# HANDBOOK
# OPERATION AND SERVICE INSTRUCTIONS

## TURBOJET ENGINES

### MODELS

| | |
|---|---|
| J47-GE-7 | J47-GE-11 |
| J47-GE-7A | J47-GE-13 |
| J47-GE-9 | J47-GE-15 |
| J49-GE-9A | J47-GE-19 |

(GENERAL ELECTRIC)

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# INTRODUCTION

This handbook provides operation and service instructions for Model J47-GE-7, J47-GE-7A, J47-GE-9, J47-GE-9A, J47-GE-11, J47-GE-13, J47-GE-15, and J47-GE-19 turbojet engines, designed and manufactured by the General Electric Company, Schenectady, New York. The instructions provide information on operation, and cover inspection and maintenance which can be performed by personnel of operating units.

Table I gives complete USAF and General Electric Company model designations. In these instructions the USAF designarions will be used with the manufacturer's initials omitted. All text and illustrations apply equally to all models unless specifically stated otherwise.

**TABLE I**
**MODEL DESIGNATIONS**

| USAF | General Electric Company |
|---|---|
| J47-GE-7 | TG-190-B1 |
| J47-GE-7A | TG-190-A1 |
| J47-GE-9 | TG-190-B3 |
| J47-GE-9A | TG-190-A3 |
| J47-GE-11 | TG-190-C11 |
| J47-GE-13 | TG-190-C13 |
| J47-GE-15 | TG-190-C15 |
| J47-GE-19 | TG-190-C19 |

# SECTION I

# OPERATION

## 1—1. GENERAL.

1—2. The J47 turbojet engine (figure 1—1) is an aircraft gas turbine for jet propulsion which operates by ejecting a volume of expanding gas from a single orifice at the rear, the propelling force resulting from the mass and high velocity of the gas as it leaves the exhaust cone.

1—3. The turbojet engine is rated in pounds of thrust rather than horsepower. Thrust exists when the velocity of the jet exceeds the velocity of the aircraft, and in-

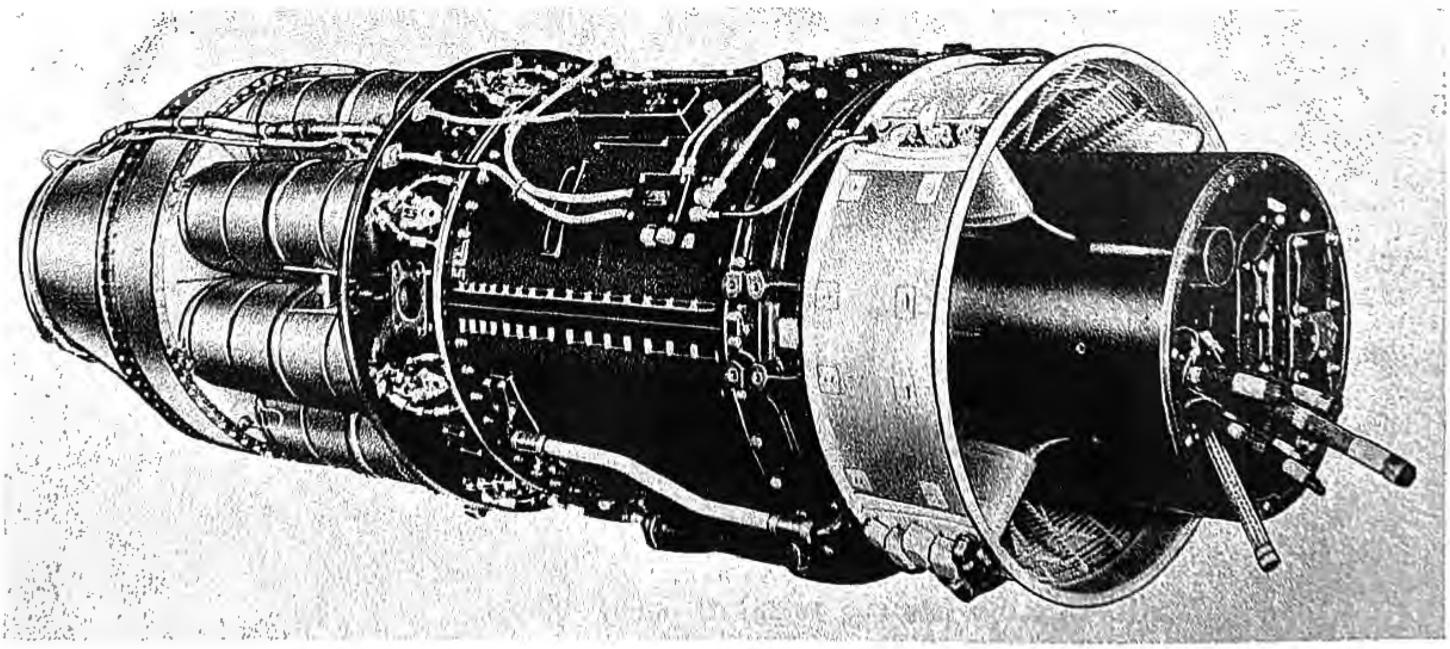


*Figure 1—1. J47 Turbojet Engine, Three-quarter Right Front View*

creases as jet velocity and air mass flow are increased. Both are governed by the amount of fuel burned, which is in turn controlled by the throttle. At high altitudes, air mass flow and fuel flow are decreased, with a resultant drop in power output. Speed remains approximately constant under these conditions, however, because of the thinner atmosphere and consequent decrease in drag. The engine is essentially a high-speed power plant which operates best at nearly maximum output. Fuel economy is not materially improved by reducing speed, since engine efficiency falls off sharply.

1–4. The turbojet engine has no reciprocating elements which contribute to weight by their necessarily heavy construction and balancing counterweights. In place of these it has carefully balanced rotating parts which produce a minimum of vibration. The engine employs a multiple-stage axial-flow compressor, a set of 8 through-flow combustion chambers, and a single-stage gas turbine. With its auxiliary components it is a complete power plant, and requires no separate equipment such as coolers, superchargers, intercoolers, or their attendant controls.

1–5. The engine is suspended at 3 points in a specially designed air compartment in the fuselage or nacelle of the aircraft. Electrical, fuel, lubrication, and instrumentation connections are made to the engine. The space around the engine is so constructed that the compressor is abundantly supplied with air. In flight, the compressor is rammed by efficiently diffused air drawn in through an aperture at the front. An exhaust pipe which provides a passage for escape of the exhaust gas is connected to the exhaust cone at the rear of the engine.

## 1–6. DEFINITIONS.

1–7. Table II defines the terms used in this publication. All the terms listed are defined with reference to the engine in flight position and apply equally at all times regardless of the engine's position at any particular time. (See figure 1–2.)

## 1–8. DIFFERENCES IN MODELS.

1–9. The J47-7 and -7A engines differ only in origin, not in configuration; therefore any statement in this publication about the J47-7 engine is equally applicable to the -7A engine. This is also the case with the J47-9 and -9A engines, respectively, which likewise differ only in origin.

1–10. The J47-7 and -9 engines are similar except for their provisions for aircraft accessories, as are the J47-13 and -15 engines. In the J47-7 and -13 engines, a hydraulic pump drive gear case with 2 fluid pump pads is mounted on the power take-off (PTO) assembly. In the J47-9 and -15 engines, an alternator pad assembly for a single alternator drive is provided on the PTO assembly. The J47-13 and -15 engines differ from the -7 and -9 engines in the design of the aft frame and turbine section components. The turbine casing on the J47-13 and -15 engines is of one-piece construction, while the -7 and -9 engines use separate parts for the exhaust cone flange shim, the transition liner support, and the turbine nozzle diaphragm ring.

1–10A. Originally, the J47-15 engine had an emergency fuel system. However, whereas the basic engine configuration remains unchanged, the emergency fuel system, consisting of the emergency fuel pump, emergency fuel regulator, double check valve, and piping and linkage, has been removed.

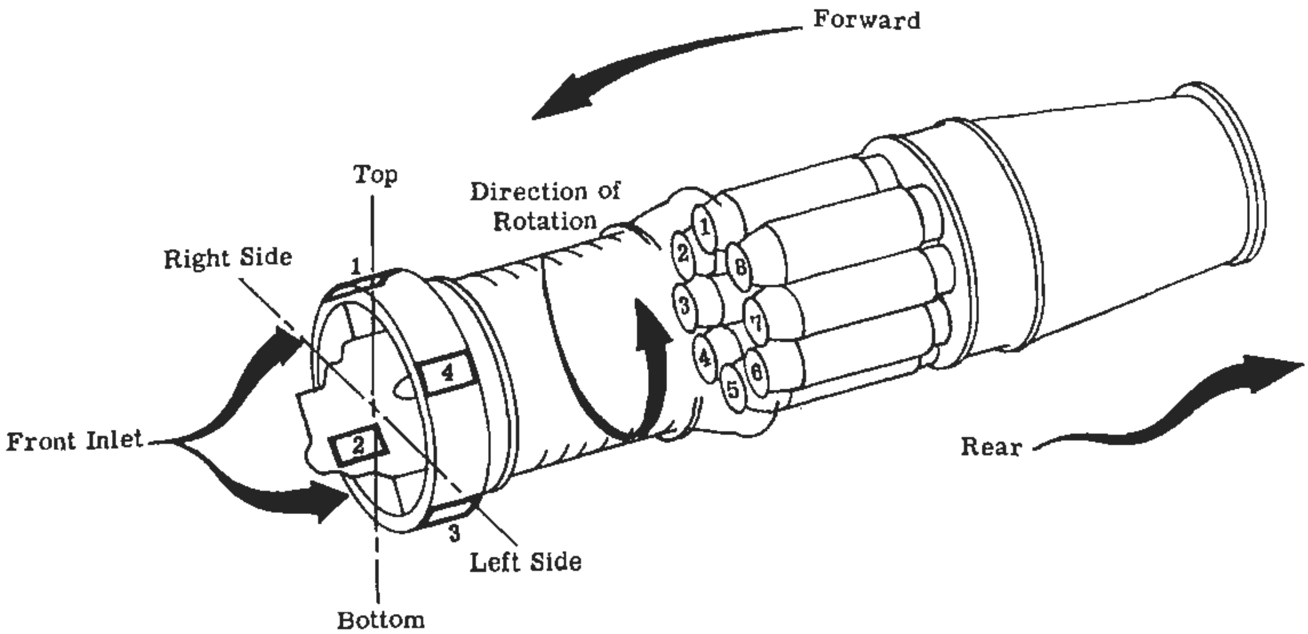



*Figure 1–2. Engine Orientation Diagram*

1—11. The J47-11 engine is basically of the same configuration as the -13 and -15 engines; however, the J47-11 engine has no provision for an emergency fuel system and no power take-off pads. An accessory support mount is provided on the PTO assembly. The ignition units are cooled with air bled from the fourth stage of the compressor.

1—12. The J47-19 engine is essentially the same as the -11 engine, except that a different type of ignition system which provides improved starting characteristics at high altitudes is used. This ignition system is of the opposite-polarity type, and uses 4 single-electrode igniter plugs and an a-c starter instead of the 2 dual-electrode igniter plugs and d-c starter-generator used in other models.

TABLE II
DEFINITIONS

| Term | Definition |
|---|---|
| FORWARD OR FRONT END | The end of the engine into which rammed air is introduced in flight. |
| REAR OR AFT END | The end from which the jet is expelled, identified by the exhaust cone. |
| RIGHT AND LEFT SIDES | With the engine and the observer facing in the direction of flight, the right side of the engine corresponds with the observer's right and the left side with the observer's left. |
| BOTTOM | The surface of the engine upon which the oil cooler and drain fittings are located. |
| TOP | The surface of the engine directly opposite or approximately 180 degrees from the oil cooler. |
| AUXILIARY OR ACCESSORY COMPONENT | A self-contained mechanism, actuated or supported by the engine, which is essential to operation of the engine or the aircraft. |
| DIRECTION OF ROTATION | The direction of rotation of the compressor rotor and the turbine rotor is clockwise as viewed by an observer looking forward from the rear. |
| NUMBERING | Two or more similar parts arranged radially around the engine, such as the combustion chambers or the air guide islands, are identified by numbers reading consecutively clockwise, starting at the top to the right of center as observed facing forward from the rear. |
| THRUST | The propelling force expressed in pounds. Thrust is the unbalanced forward force generated within the engine which results from the difference between the high pressure of combustion and the low static pressure of the high-velocity gases leaving the exhaust cone. |

**1–13. DESCRIPTION OF BASIC ENGINE.**

1–14. PRINCIPLES OF OPERATION. In the operation of the engine, rammed air enters the air guide section (3, figure 1–3) and is passed through the 12 stages of the compressor and through the compressor rear frame (10) into the combustion chambers (15). The compressed air passes from the outer combustion chamhers through a series of openings into the inner combustion chambers, where it is combined with atomized fuel injected through the fuel nozzles (11). Primary ignition is supplied by the igniter plugs (12), and combustion of the air-fuel mixture occurs. After starting, combustion is self-sustaining until the fuel is shut off. The gas resulting from combustion leaves the combustion chambers and is passed through the turbine nozzle diaphragm (18) onto tbe turbine buckets (19). A portion of the energy of the gas which passes the turbine rotor (21) is utilized to drive the turbine shaft (22) which is directly connected to the compressor rotor (8), furnishing the motive power to compress more air. As the gas leaves the turbine rotor, it passes through the exhaust cone (20) in gradually expanding form. The remainder of its energy provides the high-velocity jet and consequent reaction thrust. Thrust exists when the jet velocity relative to the aircraft exceeds the velocity of the aircraft relative to the atmosphere in which it is moving.

1–15. TURBINE. The turbine is of the single-stage gas impulse type. It consists of a nozzle diaphragm (18, figure 1–3) and a rotor and shaft assembly. The hollow turbine shaft (22) is splined at the compressor end to fit the splines in the compressor rotor shaft. The 2 shafts are held together by the turbine shaft bolt (13) which runs through the center of the turbine shaft. The turbine rotor (21) is cooled by air which is bled from the compressor. The nozzle diaphragm consists of fabricated inner and outer concentric rings between which 64 partitions are welded at equally spaced intervals to form the nozzles. The nozzle partitions do not require cooling at the temperatures to which they are exposed.

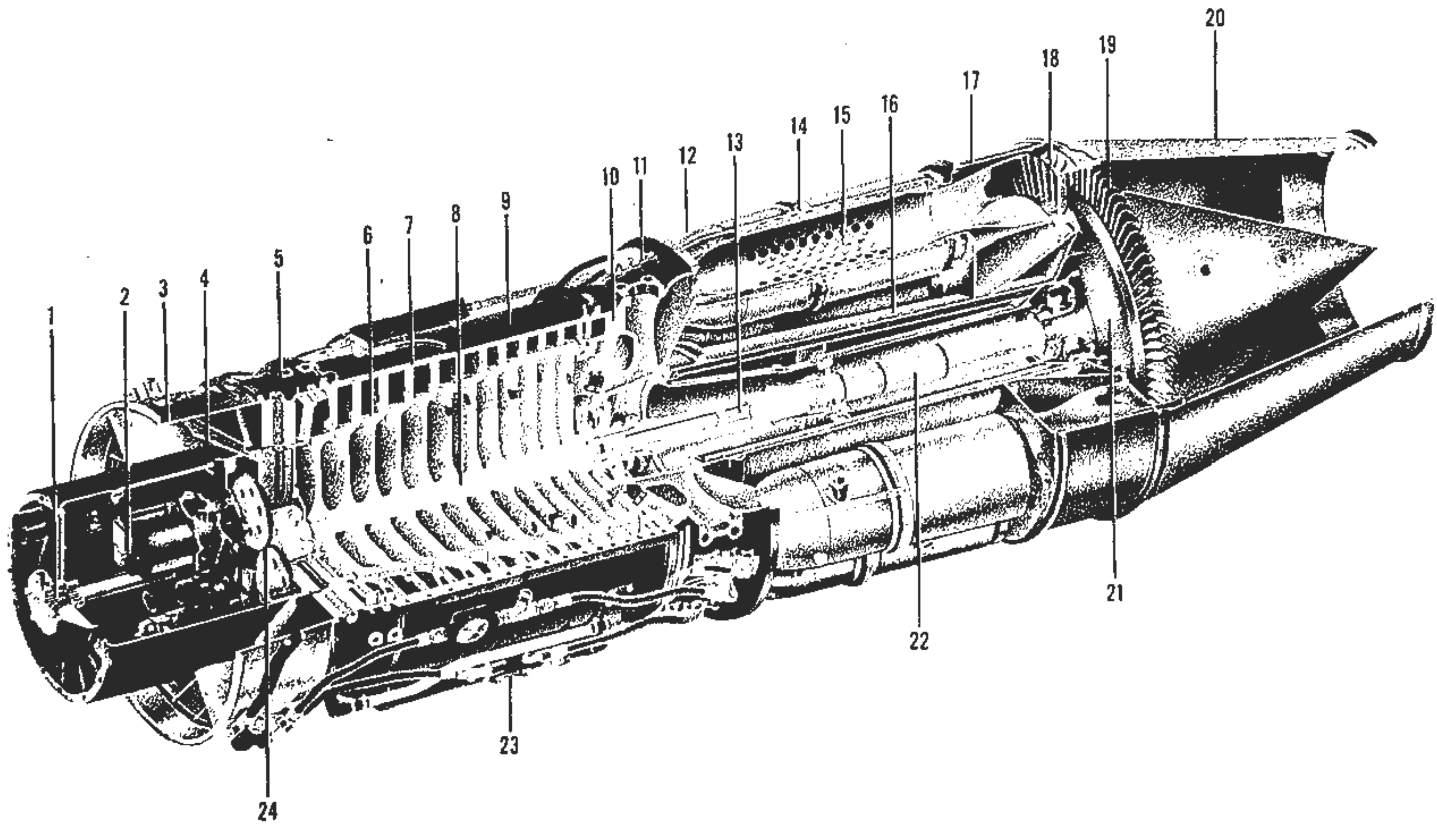
1–16. COMPRESSOR. The axial-flow type compressor consists of a compressor roror (8, figure 1–3) and compressor stator (9). The rotor consists of 12 wheels shrunk on a steel shaft. The wheels of the first 9 stages are made of aluminum; the tenth-, eleventh-, and twelfth-stage wheels are made from heat-treated steel forgings for better resistance to the higher operating temperatures and for greater strength because the twelfth-stage wheel is directly linked to the turbine shaft. A continuous ring of compressor rotor blades (6) is dovetailed into the outer rim of each wheel. The wheel rims are connected by cylindrical aluminum spacer rings which are shrunk under the wheel shoulders. Each spacer ring is secured to the adjoining higher-stage wheel by a stud pin. The compressor stator consists of 2 magnesium halves bolted together around the rotor and secured at the forward end of the compressor front frame (5) and at the aft end to the compressor rear frame (10). The compressor stator blades (7) are used to redirect the flow of air between the stages of the rotor. Complete rings of stator blades are dovetailed into the compressor stator so that they extend between each 2 rotor stages, and 3 additional inlet and exit stages are incorporated. The compressor rotor and stator blades are all removable. The compressor front and rear frames are castings. The rear frame serves as a support for the mid or No. 2 bearing, the

forward ends of the combustion chambers (15), and also for the turbine frame (16).

1—17. COMBUSTION CHAMBERS. The 8 combustion chambers (15, figure 1—3) are mounted circumferentially around the aft frame, and are supported by the compressor rear frame at their forward ends and by the aft frame at their rear ends. The forward and aft joints are secured by quick-disconnect clamps. Each combustion chamber consists of a cylindrical outer chamber and a removable inner chamber which is fitted into it. A separate fuel nozzle (11) is provided to spray fuel into each inner combustion chamber. Air passes from the compressor into the annular space between the outer and inner chambers and through perforations into the inner chambers, where it is mixed with the atomized fuel and burns. The combustion chamber assemblies are joined to each other near their forward ends by bellows-type flange connections into which cross-ignition tubes are inserted. This design allows combustion to spread from one combustion chamber to the next. In the J47-7, -9, -11, -13 and -15 engines, the dual-electrode igniter plugs (12) are mounted in the No. 2 and 7 combustion chambers. In the J47-19 engine, the single-electrode igniter plugs are mounted in the No. 3 and 7 combustion chambers.

1—18. EXHAUST CONE. The exhaust cone (20, figure 1—3) is a tapered cylindrical outlet for the gases discharged from the turbine. The assembly consists of sheet steel outer and inner cones connected by 4 radial struts. The inner cone tapers to a point on the aft end, giving the mass of ejected gas a gradually expanding form. Air for cooling the aft surface of the turbine rotor is bled from the compressor and flows through a chamber formed by the rotor and the forward end of the exhaust cone.

1—19. ACCESSORY DRIVE GEARS. The accessory drive gears (24, figure 1—3) are located in the compressor front frame center section. The auxiliary compo-



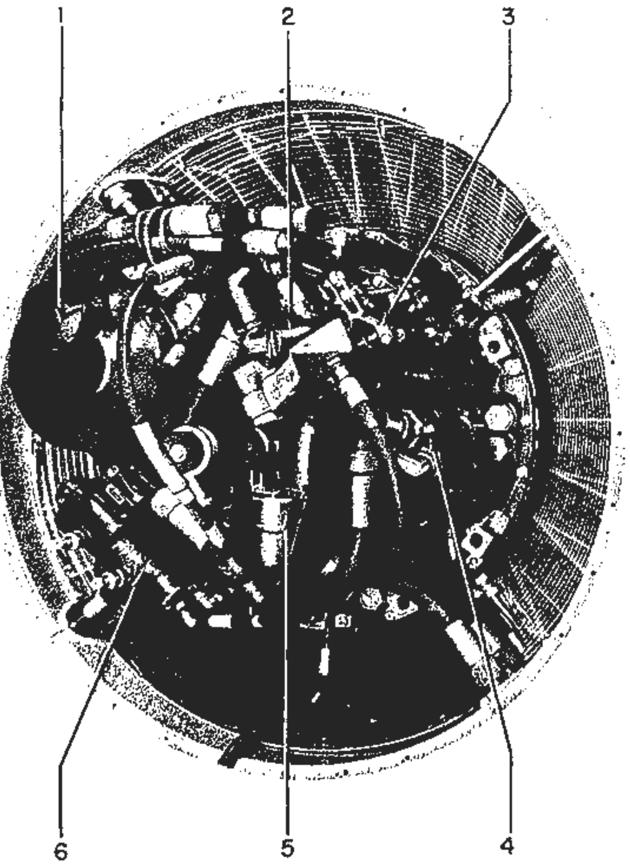

1. Alternator Pad and Drive Shaft Assembly (J47-9 and -15)
2. Auxiliary or Accessory Components
3. Air Guide Section
4. Air Inlet Screen
5. Compressor Front Frame
6. Compressor Rotor Blades
7. Compressor Stator Blades
8. Compressor Rotor
9. Compressor Stator
10. Compressor Rear Frame
11. Fuel Nozzle
12. Igniter Plug
13. Turbine Shaft Bolt
14. Water-injection Manifold
15. Combustion Chamber
16. Turbine Frame
17. Turbine Casing
18. Turbine Nozzle Diaphragm
19. Turbine Buckets
20. Exhaust Cone
21. Turbine Rotor
22. Turbine Shaft
23. Oil Cooler
24. Accessory Drive Gears

*Figure 1—3. Cutaway View of Engine*

nents or accessories are mounted on pads on the forward surface of the accessory drive gear box and are splined to reduction gears that mesh with pinions on a common drive shaft. The drive shaft is coupled to the compressor rotor shaft. The gear ratios in relation to the accessory drive pinion which is splined to the compressor rotor shaft are given below:

a. Main fuel regulator drive: 0.455.
b. Main fuel pump drive: 0.455.
c. Emergency fuel pump drive: 0.455.
d. Starter-generator drive: 0.921.
e. Main lube pump drive: 0.528.

1—20. MODEL J47-7, -9, AND -13, AUXILIARY AND ACCESSORY COMPONENTS. The main fuel pump (4, figure 1—4), emergency fuel pump, main lube pump, main fuel regulator, and the starter-generator (1) are mounted on the accessory drive gear box at the forward end of the engine. The stopcock and main fuel regulator linkage (3), stopcock, and double check valve are mounted on the main fuel regulator. The fuel filter (5), fuel control valve (6), and regulator oil filter and orifice (2) are connected to the above auxiliary components by hose lines, and are bolted to the hydraulic pump drive gear case on J47-7 and -13 engines, or the alternator pad assembly on the J47-9 engine. The tachometer-generator is bolted to a pad on the main lube pump. A double-element scavenge pump, driven by a reduction gear train from the rotor shaft, is mounted in the compressor rear frame. This pump scavenges oil from the mid (No. 2), damper (No. 3), and aft (No. 4) bearings. The oil cooler, which uses fuel as the cooling medium, is mounted to the bottom of the compressor stator. The emergency fuel regulator, which operates in conjunction with the emergency fuel pump, is mounted on the compressor front frame near the top centerline.




1. Starter-generator
2. Regulator Oil Filter and Orifice
3. Stopcock and Main Fuel Regulator Control Linkage
4. Main Fuel Pump
5. Fuel Filter
6. Fuel Control Valve

*Figure 1—4. J47-7 Auxiliary Components*

1—21. MODEL J47-11, -15, AND -19 AUXILIARY AND ACCESSORY COMPONENTS. Since the J47-11, -15, and -19 engines have no emergency fuel system, there is no emergency fuel pump, emergency fuel regulator, double check valve, or the piping and linkage required for these parts. On the J47-11 and -19 engines, the fuel filter, fuel control valve, and regulator oil filter and orifice are mounted on an accessory support mount. The J47-15 engine has these parts mounted on an alternator pad assembly similar in design to the J47-9 engines. The J47-19 engine has an a-c starter instead of the d-c starter-generator used in other models, and 2 ignition transformers mounted to the top half of the compressor stator instead of d-c ignition units.

## 1—22. DESCRIPTION OF ELECTRICAL SYSTEM.

1—23. MODEL J47-7, -9, -11, -13, AND -15 ENGINES.

1—24. The electrical system (figure 1—5) has 2 primary functions: to provide energy for starting and ignition, and to supply current to the aircraft. Power for starting on the ground is supplied by an external power source.

1—25. When the engine switch is turned on to energize the control circuits, and the momentary-contact starter and ignition switch is pressed to energize the starter contactor and ignition relays, the 24-volt supply is connected to the starter system and the ignition system. When the starter contactor relay is energized, current passes through the undercurrent relay and then through the starter. The ignition system, however, does not become energized until the throttle microswitch, which is controlled by the throttle, is closed. In starting, the throttle remains closed until the engine reaches a speed of 6 percent rpm. The throttle is then advanced to the idle detent position. This throttle movement opens the stopcock, permitting fuel to flow, and closes the microswitch, energizing the ignition system. In this manner, the microswitch ensures the proper conditions for combustion before permitting ignition to occur.

1—26. The undercurrent relay short-circuits the starter and ignition switch, allowing current to continue to flow to the throttle microswitch, even though the momentary-contact starter and ignition switch has been released. The 2 igniter plugs are mounted in the No. 2 and 7 combustion chambers. Each igniter plug consists of a

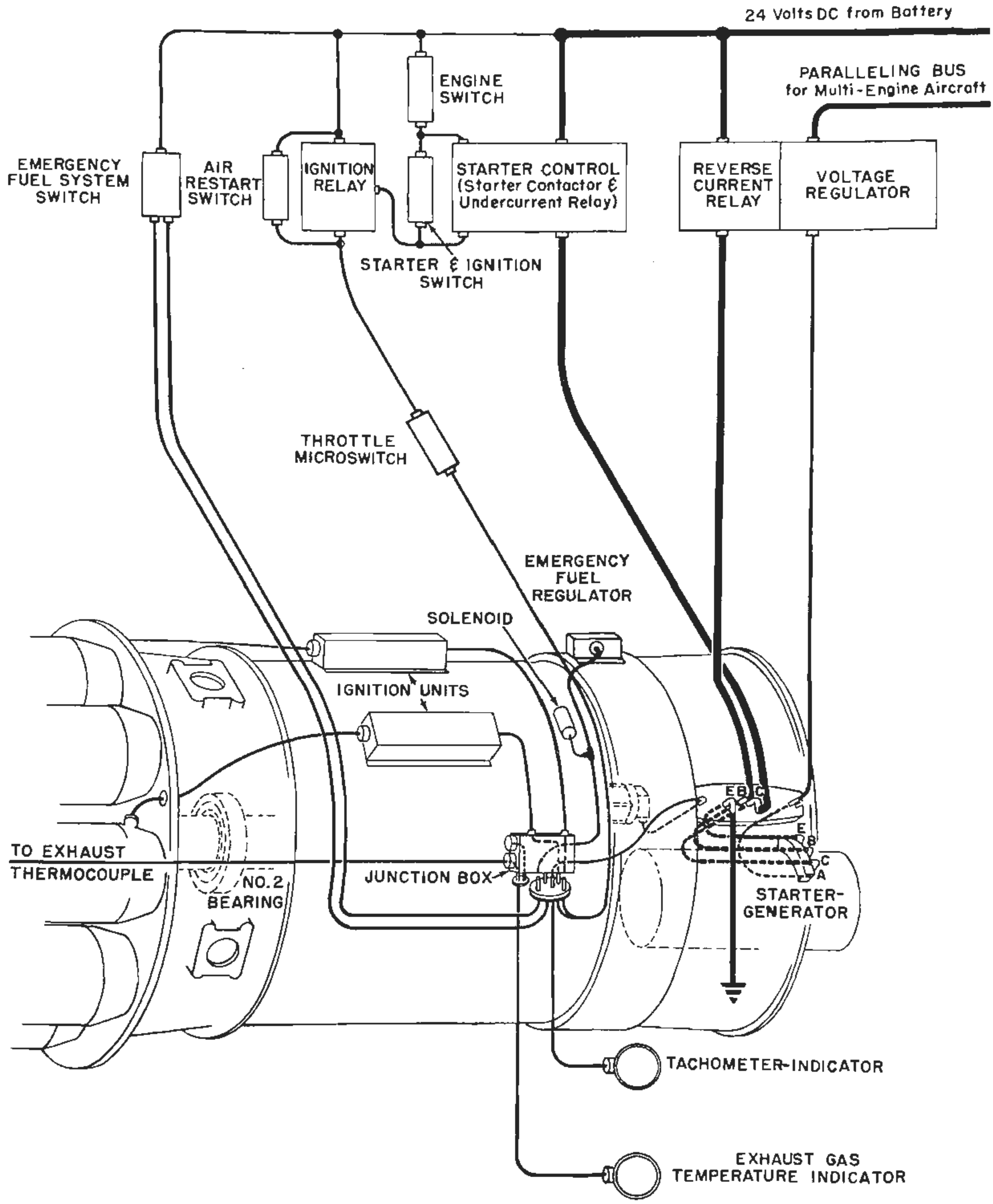



*Figure 1—5. J47-7, -9, -11, -13, and -15 Electrical System Schematic*

central high-tension electrode in a porcelain bushing and a grounded electrode. The igniter plug gap is 0.090 to 0.110 inch.

1—27. The starter-generator functions as a d-c motor to accelerate the rotor to the speed at which combustion will occur upon ignition. After ignition occurs, sufficient energy becomes available from the hot combustion gases to enable the turbine, in conjunction with the starter, to accelerate the engine to a minimum stable operating speed of 2000 rpm. This speed is reached approximately 2 minutes after starting. As the engine reaches a stable operating speed, the starter draws a diminishing amount of current until the undercurrent relay is de-energized. This breaks the circuit through the ignition relay and starter contactor. At speeds over 4000 rpm, the starter-generator functions as a generator and supplies rated generator load.

1—28. The reverse current relay functions to prevent current from the aircraft's batteries from flowing back into the generator when battery voltage is higher than that of the generator. The voltage regulator controls the voltage output of the generator by controlling the amount of current passing through the shunt field.

1—29. The air restart toggle switch should remain in the "NORMAL" position during ground starts. To attempt a start in flight, the switch must be held in the "AIR START" position until combustion occurs and then returned immediately to the "NORMAL" position. The "AIR START" position may also be used for ground checks of the ignition system.

1—30. A tachometer-generator is mounted on the forward surface of the main lube pump. The leads are brought out to the No. 1 island and from there to the junction box. From the junction box another lead connects the tachometer-generator to the tachometer-indicator located in the pilot's compartment.

1—31. MODEL J47-19 ENGINE.

1—32. Model J47-19 engines are equipped with a 3-phase 200-volt 400-cycle a-c starter motor in place of the starter-generator used on other models. Ignition is provided by 2 transformers mounted on the compressor stator. The transformers step up the 115-volt 400-cycle a-c supply voltage to 20,000 volts. The voltage to each igniter plug is of opposite polarity, so that a 40,000-volt potential is set up between the single-electrode igniter plugs mounted 2 each in the No. 3 and 7 combustion chambers. The gap between the 2 opposing plugs in each chamber is approximately 3/8 to 1/2 inch.

## 1—33. DESCRIPTION OF LUBRICATION SYSTEM.

**Note**

The location and function of the major lubrication system components is given in paragraphs 1—34 through 1—36, and lube oil circulation is described in paragraphs 1—37 through 1—42. This information covers engines which use the W. H. Nichols Company Model No. NC279 3-element main lube pump. All engines which initially used the W. H. Nichols Company Model No. NC251 3-element pump or the Model No. NC221 2-element pump are being modified to the configuration described in these paragraphs. A description of the system which uses the 2-element pump is given, however, in paragraphs 1—43 and 1—44.

1—34. LOCATION AND FUNCTION OF MAJOR LUBRICATION SYSTEM COMPONENTS. (See figure 1—6.)

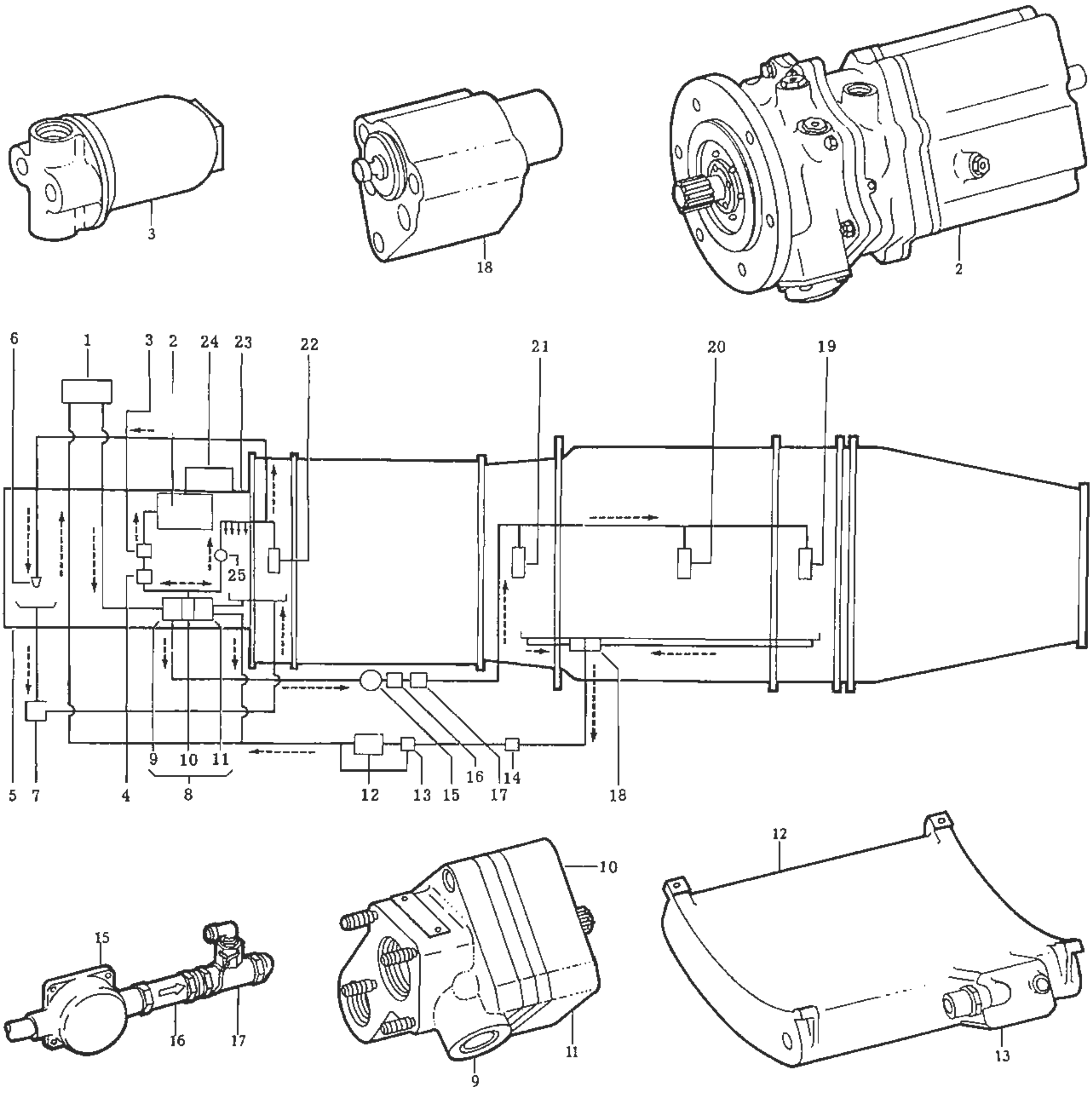
1—35. The engine uses a recirculating positive-displacement lubrication system. The main lube pump (8) is a 3-element positive-displacement hydraulic pump. It is mounted on the accessory drive gear box and is driven by the compressor rotor through a reduction gearing. It contains 2 service elements (9 and 10) and a single scavenge element (11). The aft scavenge pump (18) is a double-element constant-displacement hydraulic pump which is mounted in the compressor rear frame and is driven by the rotor through reduction gears. On J47-13 engines with serial No. 046927 and above, a PTO scavenge pump (7) is splined to the lower PTO gear shaft through a bearing seal at the rear of the hydraulic pump drive gear case. It returns oil from the hydraulic pump drive gear sump to the accessory drive gear box.

1—36. The regulator oil filter and orifice (3) is mounted on a bracket attached to the rear of the hydraulic pump drive gear case on J47-7 and -13 engines, alternator pad assembly on J47-9 and -15 engines, or accessory support mount on J47-11 and -19 engines. It meters cooling oil to the main fuel regulator (2). The oil cooler (12) is mounted on the bottom surface of the compressor stator and transfers heat from the scavenged oil to the fuel going to the combustion chambers. Check valves (4, 14, and 16) prevent the oil lines and the oil tank from being completely drained when the engine is not running.

1—37. LUBE OIL CIRCULATION (3-ELEMENT MAIN LUBE PUMP).

1—38. Lube oil from the airframe-mounted supply tank (1, figure 1—6) enters the main lube pump (8) through the No. 2 island. Oil from the small service element (10) of this pump goes through a "T" fitting into cored and drilled passages in the accessory drive gear box (23). Jets conduct the oil from these passages to the accessory drive reduction gears, the starter-generator drive gear, the splined connection between the compressor rotor shaft and the accessory drive pinion, and to the front (No. 1) bearing (22). On J47-13 engines with serial No. 046927 and above, oil from the accessory drive gear box line is also carried forward and sprayed on the gears in the hydraulic pump drive gear case. This oil is collected in the sump and pumped back to the top of the accessory drive gear box by the PTO scavenge pump (7).

1—39. The oil from the small service element of the main lube pump which goes out the other side of the "T" fitting is used for cooling and constantly controlled oil (CCO) supply purposes. From the "T" it goes through a swing check valve (4) and the regulator oil filter and orifice (3) to the main fuel regulator. This oil is metered




1. Supply Tank
2. Main Fuel Regulator
3. Regulator Oil Filter and Orifice
4. Swing Check Valve
5. Power Take-off Assembly
6. PTO Gears
7. PTO Scavenge Pump (J47-13 only)
8. Main Lube Pump
9. Main Lube Pump Large Service Element
10. Main Lube Pump Small Service Element
11. Main Lube Pump Scavenge Element
12. Oil Cooler
13. Bypass and Relief Valve
14. Swing Check Valve
15. Main Lube Filter
16. Check Valve
17. Pressure Tap
18. Aft Scavenge Pump
19. Turbine (No. 4) Bearing
20. Damper (No. 3) Bearing
21. Mid (No. 2) Bearing
22. Front (No. 1) Bearing
23. Accessory Drive Gear Box
24. Drain to Gear Box
25. Filter

*Figure 1—6. Lubrication System Schematic*

to the main fuel regulator at the rate of 1-1/2 quarts per minute. Its cooling action completed, it then drains back into the accessory drive gear box.

1—40. The main lube pump scavenge element (11) forces oil from the accessory drive gear box sump to the scavenge manifold on the No. 3 island. From the scavenge manifold the oil is returned to the supply tank.

1—41. Lube oil from the main lube pump large service element (9) goes through an elbow in the No. 3 island, the main lube filter (15), and a check valve (16). From the check valve it enters passages in the compressor rear frame and is conducted by jets onto the mid (No. 2) bearing (21), the damper (No. 3) bearing (20), and the turbine (No. 4) bearing (19).

1—42. The No. 2 bearing is located in the compressor rear frame and the No. 3 and 4 bearings in the turbine frame housing. To prevent oil leakage, there is an air-oil seal at the forward end of the compressor rear frame and a 2-stage labyrinth air-oil seal at the aft end of the turbine frame housing. A lube oil breather mounted on the housing maintains a slight vacuum (equal to 3 to 9 inches $H_2O$) which causes air to flow in from the higher-pressure regions at both ends. This in-flowing air helps to prevent oil leakage past the seals, and a built-in baffle prevents oil from leaking out through the breather. The oil collects in the aft frame sump and is scavenged by the aft scavenge pump (18). From here the scavenge oil is pumped through a swing check valve (14), the bypass and relief valve (13), and the oil cooler (12), to the scavenge manifold on the No. 3 island, from which it returns to the supply tank. The bypass and relief valve is thermostatically controlled and at oil temperatures less than 15°C (60°F), or at oil pressures above 70 psi, bypasses all oil. Heat is absorbed from the oil by the fuel at a minimum rate of 500 BTU per minute. At 32°C (90°F), the bypass and relief valve is fully open and all oil passes through the oil cooler.

1—43. LUBE OIL CIRCULATION (2-ELEMENT MAIN LUBE PUMP).

1—44. The main lube pump used in this system has one service and one scavenge element. Lube oil from the service element passes through one of the sides of a "T" fitting and a connection on the No. 3 island to lubricate the No. 2, 3, and 4 bearings, following the same route described in paragraph 1—41 for systems which use the 3-element main lube pump. Oil from the other side of the "T" fitting goes through the regulator oil filter and orifice to the main fuel regulator. This oil drains into the accessory drive gear box. Another line from the service element of the main lube pump directs oil through a filter into the accessory drive gear box and the compressor front frame. Five jets spray this oil onto the accessory drive gears and one jet is used to lubricate the No. 1 bearing. Scavenge oil from the No. 2, 3, and 4 bearings and from the accessory drive gear box follows the same route as that described for the lube system which uses the 3-element pump. Check valves in the system prevent the oil lines and the supply tank from being completely drained when the engine is not running.

## 1—45. DESCRIPTION OF FUEL SYSTEM.

1—46. MODEL J47-11, -15, AND -19 ENGINES.

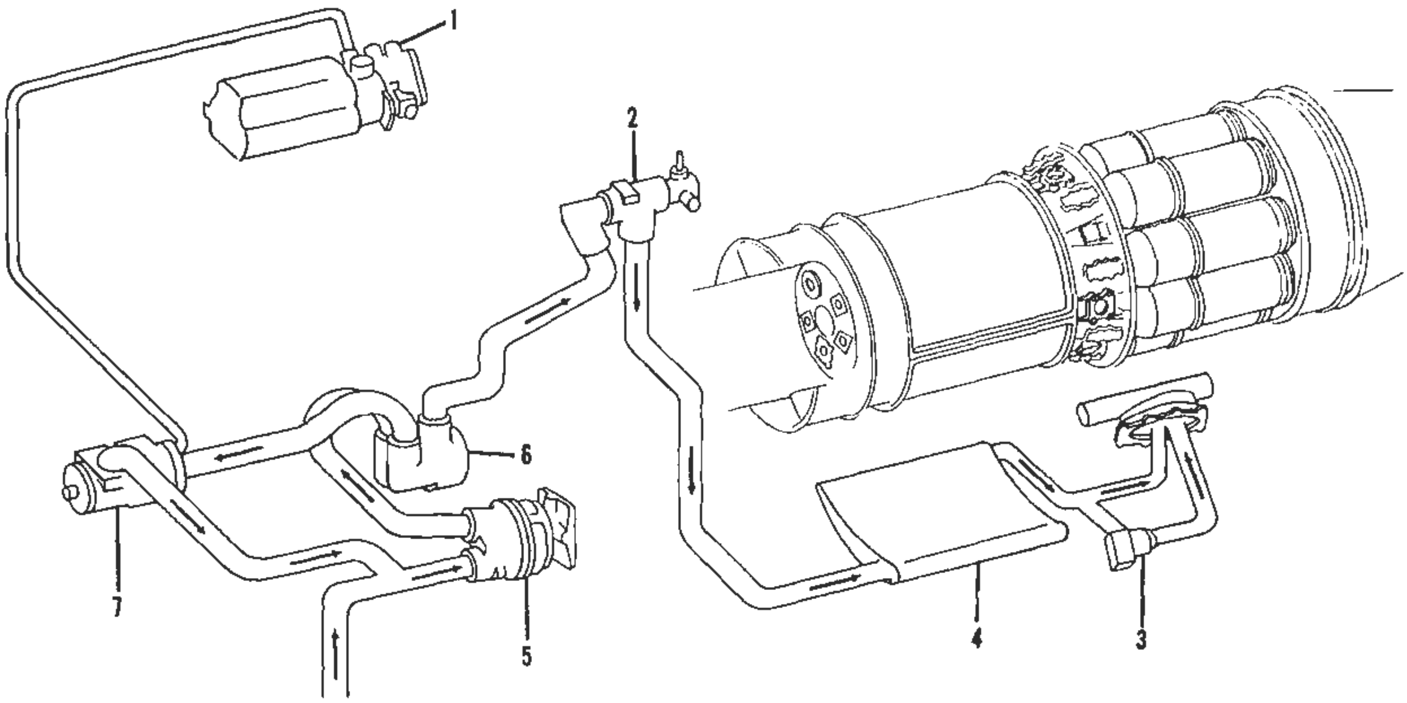
1—47. GENERAL. The fuel system components of the J47-11, -15, and -19 engines are shown on figure 1—7. In operation, the system has 2 component systems: the fuel control system which determines engine fuel pressure, and the fuel supply system which delivers fuel to the nozzles under pressure. No emergency fuel system is incorporated in the J47-11, -15, and -19 engines.

1—48. FUEL CONTROL SYSTEM. The main fuel regulator (1, figure 1—7) is the governing mechanism of the fuel control system. The main fuel regulator varies the variable control oil (VCO) pressure which in turn controls fuel pressure by means of the fuel control valve (7). The VCO pressure is itself determined within the main fuel regulator by 3 factors: the setting of the pilot's controls; the conditions of altitude, airspeed, and temperature; and the allowable operating limits of the engine.

1—49. The fuel control valve is a bypass valve which is governed by VCO pressure. It is designed to provide the proper fuel flow to the engine by means of bypassing the fuel not needed for engine operation back to the inlet of the main fuel pump (5). Construction of the valve is such that fuel pressure is maintained at approximately 3 times that of VCO pressure.

1—50. In operation, if a higher fuel pressure is called for (either by the pilot's opening the throttle or as a result of the regulator compensating for an increase in atmospheric pressure), VCO pressure in the regulator increases, causing the fuel control valve to close. This restricts the flow of bypassed fuel to the main fuel pump inlet and results in a higher fuel pressure in the line to the fuel nozzles. If a lower fuel pressure is called for, however, VCO pressure decreases and the fuel control valve opens. More fuel is bypassed to the main fuel pump, and at the same time fuel pressure in the line to the nozzles decreases until it is in balance with the VCO pressure.

1—51. FUEL SUPPLY SYSTEM. The main fuel pump (5, figure 1—7) discharges directly to the fuel filter (6) which filters the total output of the pump. One of the filter outlets leads to the fuel control valve, which is positioned to give the required engine fuel pressure as described in the previous paragraphs. The remaining fuel at engine pressure is directed through the manually controlled stopcock (2) to the oil cooler (4) and flow divider (3). In the flow divider, the fuel flow is divided and directed through the large and small slot fuel manifolds to the 8 dual-orifice fuel nozzles. At low fuel pressures, the flow divider meters the fuel only to the small slot orifices, which are designed to provide the correct spray pattern for starting. The flow divider supplies fuel to both the large and small slot manifolds and fuel nozzle orifices at all engine speeds above starting.




1. Main Fuel Regulator
2. Stopcock
3. Flow Divider
4. Oil Cooler
5. Main Fuel Pump
6. Fuel Filter
7. Fuel Control Valve

*Figure 1—7. J47-11, -15, and -19 Fuel System Schematic*

1—52. MODEL J47-7, -9, AND -13 ENGINES.

1—53. GENERAL. The fuel system components of the J47-7, -9, and -13 engines are shown on figure 1—8. Operation of the main fuel system is essentially the same as that described for the J47-11, -15, and -19 engines fuel system in paragraphs 1—46 through 1—51 above. An emergency fuel system, which will take over fuel control and supply in the event that the main fuel system fails, is also provided, however.

1—54. EMERGENCY FUEL SYSTEM. The fuel system components which are functional parts of the emergency fuel system only are the emergency fuel regulator (4, figure 1—8) and the emergency fuel pump (2). The emergency fuel pump operates constantly while the engine is in operation, but is loaded only when the emergency fuel system supplies fuel to the double check valve and stopcock (3). As long as the main fuel pump discharge pressure is maintained, the emergency fuel regulator restricts the output of the emergency fuel pump back into the supply to both fuel pumps. In the event that the main fuel pump discharge pressure falls to a value less than that scheduled by the emergency fuel regulator, this regulator restricts the flow of fuel which normally goes from the emergency fuel pump back to the supply inlet. Output of the emergency fuel pump is then forced through the double check valve and stopcock, and follows the same route to the fuel nozzles as that followed when the main fuel system is in operation. Under stabilized conditions for a given throttle position, the emergency fuel regulator always calls for a slightly lower fuel pressure than the main fuel regulator. This prevents the emergency fuel system from controlling fuel pressure when the main fuel system is operative. Since the emergency regulator is scheduled to a lower pressure than the main fuel regulator, engine speed decreases slightly when the emergency system comes into operation.

1—55. EMERGENCY FUEL SYSTEM SWITCH. A solenoid in the compressor discharge pressure line to the main fuel regulator and a solenoid on the emergency fuel regulator are controlled by the 3-position emergency fuel system switch which provides a means of checking the operation of the main and emergency fuel systems. (See figure 1—5.)

a. With the switch in the "ON" position, the emergency fuel regulator operates normally, bypassing fuel from the emergency fuel pump or controlling fuel pressure, depending on whether or not the main fuel system is operative.

b. With the switch at "OFF," the emergency fuel regulator is set at the full bypass position, and is prevented from overriding the main fuel system under normal operation.

c. With the switch at the "TEST" position, the compressor discharge pressure sensing line to the main fuel regulator is vented to the atmosphere. This fails the main fuel system and provides a means of checking that the emergency fuel system will take over fuel control with only a slight drop in engine speed.

## 1—55A. DESCRIPTION OF SPECIAL TEST EQUIPMENT.

1—55B. JETCAL TESTER.

1—55C. GENERAL. The Jetcal tester, USAF Stock No. 7CAD-807205, 7CAD-811595, 7CAD-807275, and 7CAD-807280, is used to test the exhaust gas temperature indication system of the aircraft. Refer to the applicable aircraft service handbook for the specific stock number to be used.

1—55D. The Jetcal tester consists of cables, heater probes, and a temperature-calibrated potentiometer which is essentially an independent exhaust gas temperature indication system. The Jetcal tester can be used to check the engine exhaust gas temperature indication system components (thermocouples, harness, and indicator) either individually or as a system. Refer to the applicable service handbook for operating instructions. The Jetcal tester has the following applications:

a. Trouble-shooting the exhaust gas temperature indication system. (Refer to paragraph 4—6A.)

b. Checking out the exhaust gas temperature indication system during post-operational checks. (Refer to paragraph 3—12.)

c. Adjusting the jet nozzle area. (Refer to paragraph 1—75.)

## 1—56. LEADING PARTICULARS AND OPERATING LIMITS.

1—57. DIMENSIONS AND WEIGHTS. Table III gives the overall dimensions and approximately dry weights of the J47-7, -9, -11, -13, -15, and -19 engines.

1—58. GYROSCOPIC MOMENTS. When properly mounted, the engine will stand a gyroscopic moment imposed by a steady angular velocity of 3-1/2 radians

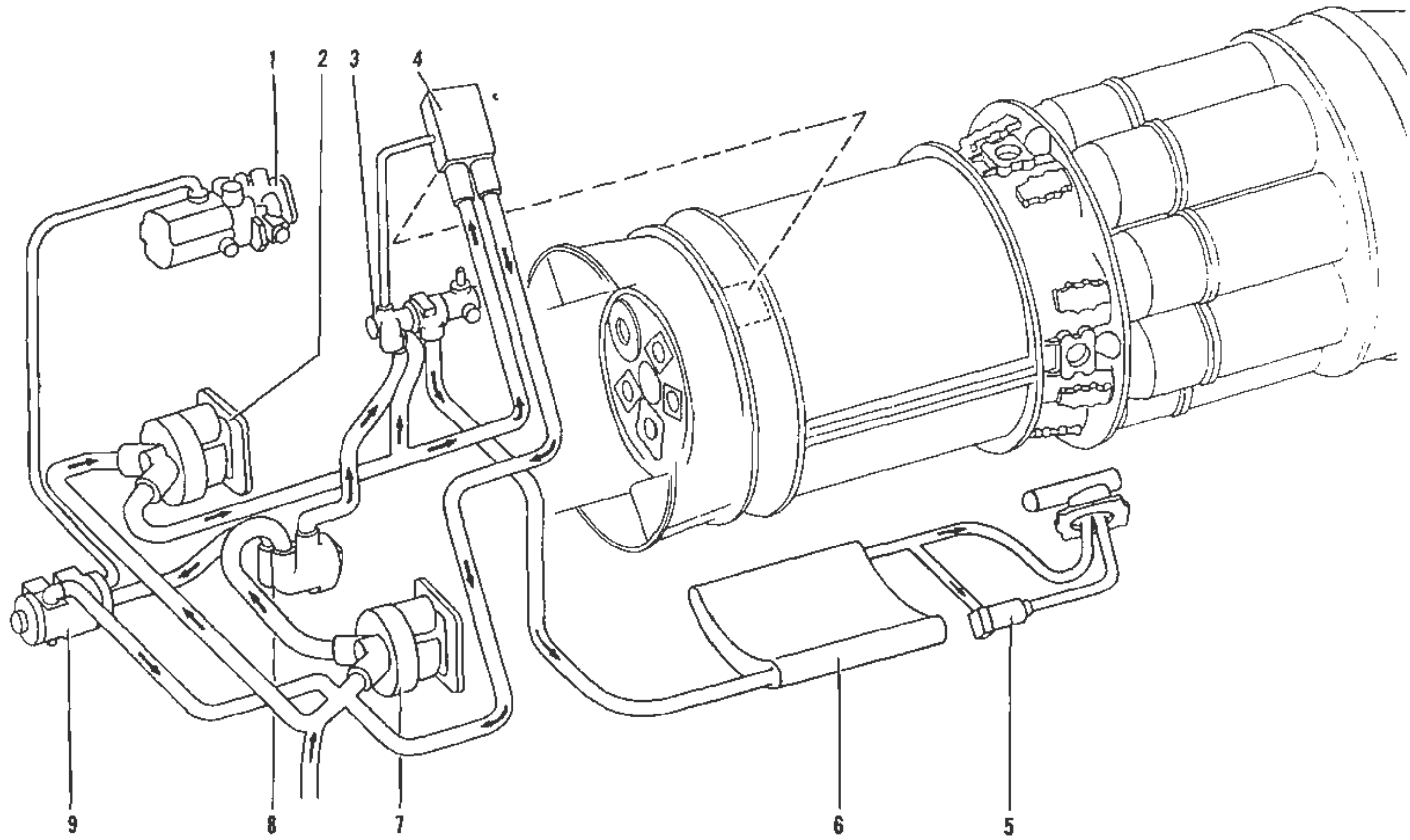
per second in engine yaw for a period of 30 seconds, and a peak angular velocity of 6 radians per second for 2 seconds.

1—59. TEMPERATURE LIMITS. The engine is designed to operate within the ambient air temperature range of —54°C (—65°F) to +71°C (+160°F). A low viscosity lubricating oil must be used when operating at low ambient temperatures. (Refer to paragraph 1—62.) It is recommended that the control system be preheated and that fuel with high volatility be used when operating the engine at low temperatures. (Refer to paragraph 1—61.)

**TABLE III**

**DIMENSIONS AND WEIGHTS**

| Model | Length (in.) | Width (in.) | Height (in.) | Diameter (in.) | Weight (lb) |
|---|---|---|---|---|---|
| J47-7 | 144 | 37 | 37 | 39 | 2525 |
| J47-9 | 144 | 37 | 37 | 39 | 2515 |
| J47-11 | 144 | 37 | 37 | 39 | 2475 |
| J47-13 | 144 | 37 | 37 | 39 | 2525 |
| J47-15 | 144 | 37 | 37 | 39 | 2515 |
| J47-19 | 144 | 37 | 37 | 39 | 2495 |




1. Main Fuel Regulator
2. Emergency Fuel Pump
3. Double Check Valve and Stopcock
4. Emergency Fuel Regulator
5. Flow Divider
6. Oil Cooler
7. Main Fuel Pump
8. Fuel Filter
9. Fuel Control Valve

*Figure 1—8. J47-7, -9, and -13 Fuel System Schematic*

## TABLE IV

## FUEL AND LUBE SPECIFICATIONS

| Ambient Air Temperature | USAF Specification | |
|---|---|---|
| | Fuel | Lubricating Oil |
| Above —35°C (—30°F) | MIL-F-5624A, Grade JP-4<br>*MIL-F-5624A, Grade JP-3<br>*MIL-F-5616, Grade JP-1 | MIL-O-6081A, Grade 1005<br>*MIL-O-6081A, Grade 1010 |
| Below —35°C (—30°F) | MIL-F-5624A, Grade JP-4<br>*MIL-F-5624A, Grade JP-3 | MIL-O-6081A, Grade 1005 |

* Alternates

1—60. ALTITUDE. The engine is designed to function satisfactorily up to and including an altitude of 50,000 feet, and up to and including a ram pressure of 1.8.

1—61. FUEL SYSTEM. Table IV lists the USAF specifications of the fuel to be used in the engine, according to the prevailing ambient air temperature at ground level. Refer to table V for primary, or small slot, fuel pressure limits.

## TABLE V

## PRIMARY (SMALL SLOT) FUEL PRESSURE

| Condition | Pressure (psi) | | |
|---|---|---|---|
| | Minimum | Normal | Maximum |
| Starting (ground) | 20 | 20—30 | 40 |
| Idle rpm (ground) | 35 | 35—50 | — |
| All other | 40 | 40—400 | 600 |

1—62. LUBRICATION SYSTEM. Table IV lists the USAF specifications of the lubricating oil to be used in the engine, according to the prevailing ambient air temperature at ground level. Table VI provides the minimum, normal, and maximum values for lube oil pressure, temperature, and consumption.

**CAUTION**

During normal stabilized operation, an increase of 5 to 10 psi above normal lube oil pressure indicates a partial stoppage in the lube system. The oil filters and lines should be checked as soon as possible for restrictions, the pressure gage for malfunction, and the oil sump magnetic plugs for metal particles.

**Note**

Use oil conforming to Specification MIL-O-6081A, Grade 1005, in multi-engine aircraft which are subject to routine noncontinuous operation at high altitudes, regardless of the ambient ground temperature.

1—63. MINIMUM ACCEPTABLE PERFORMANCE RATINGS. Minimum acceptable performance ratings and associated information are given for the J47-7 and -9 engines in table VII. Table VIII presents this information for the J47-11 and -19 engines, and table IX for the J47-13 and -15 engines.

1—64. OPERATIONAL SPEED (RPM) LIMITS. Refer to tables VII, VIII, and IX for operational speed (rpm) limits. Normal rated speed is the maximum speed designated for continuous operation. Take-off rated speed is permissible for a duration of 5 minutes only, while military rated speed is permissible for 30 minutes. Idle speed is the minimum speed which will permit satisfactory acceleration regardless of altitude and flight conditions.

**CAUTION**

Although throttle linkages are adjusted to permit maximum engine speed at 100 to 101 percent military rpm in order to insure operation at 100 percent rpm, all but momentary operation at speeds above 100 percent rpm should be avoided.

## TABLE VI

## LUBE OIL PRESSURE, TEMPERATURE, AND CONSUMPTION

| | Minimum | Normal | Maximum |
|---|---|---|---|
| PRESSURE (Stabilized Operation) | | | |
| Military (100%) rpm | 10 psi | 15—45 psi | *50 psi |
| Cruise (88%) rpm | 5 psi | 10—30 psi | *40 psi |
| Idle (25%) rpm | Some Indication | 1—10 psi | *10 psi |
| TEMPERATURE | | | |
| All conditions | —54°C (—65°F) | —40—+70°C (—40—+158°F) | 70°C (158°F) |
| CONSUMPTION | | | |
| All conditions | 0 lb/hr | 0.5—1.5 lb/hr | 2.5 lb/hr |

*During cold weather starts, oil pressures may exceed maximum limits until oil temperatures stabilize.

1–65. OVERSPEED LIMITS. Engine overspeed operation exceeding 104 percent military rpm, with or without overtemperature, requires that the engine be removed from the aircraft and forwarded to an approved AMC activity with complete records of the overspeed operation.

**Note**

Each occurrence of overspeed operation shall be recorded on USAF forms 1A and 41B.

1–66. OPERATIONAL EXHAUST GAS TEMPERATURE LIMITS. Refer to tables VII, VIII, and IX for minimum and maximum operational exhaust gas temperature limits. The engine should not be operated continuously at exhaust gas temperatures which exceed 690°C (1275°F). In some cases the exhaust gas temperature of engines operating at 100 percent rpm will exceed 690°C (1275°F), even though the jet nozzle tab is adjusted to give the maximum jet nozzle area. (Refer to paragraph 1–75.) If this occurs, reduce engine speed in order to keep the exhaust gas temperature below 690°C (1275°F). Rated take-off and military thrust will still be available during operation between 96 and 100 percent rpm.

1–67. OVERTEMPERATURE LIMITS.

**Note**

Every occurrence of exhaust gas temperatures exceeding the limits of step "b," below, shall be recorded on USAF forms 1A and 41B in order that reliable overtemperature records will be available.

a. If an engine has been operated for any length of time with an exhaust gas temperature of 1000°C (1832°F) or higher, the engine must be returned to an approved AMC activity prior to flight.

b. Any 5 starts and/or accelerations during which the exhaust gas temperature exceeds 715°C (1320°F) for more than 20 seconds or 870°C (1600°F) for any length of time constiture overtemperature operation, and require that the engine be given the special overtemperature

inspection called for in paragraph 3—14 prior to the next flight.

c. Two overtemperature operation periods as defined in step "b" above [a total of 10 starts and/or accelerations during which the exhaust gas temperature exceeds 715°C (1320°F) for more than 20 seconds or 870°C (1600°F) for any length of time] constitute overtemperature operation which requires that the engine be returned to an approved AMC activity prior to flight.

1—67A. OIL DEFICIENCY LIMITS. If the bearings have received an insufficient supply of oil within the acceptable limits for the condition listed below, check for vibration and inspect for metal particles as described in paragraph 3—15A. If the acceptable limits described below are exceeded, return the engine to an approved AMC activity for overhaul.

a. With no oil supplied to the bearings:

(1) The engine may run under its own power up to 5 minutes.

(2) The engine may windmill up to 15 minutes.

b. With oil supplied intermittently to the bearings, such as when the engine has been shut down in flight and it is necessary to shut off the oil supply intermittently, the engine may windmill with no oil supplied for a total of 25 minutes, provided no single shut-off period is longer than 5 minutes and oil is supplied in between shut-off periods for a minimum of 5 minutes.

c. With a normal windmilling supply of oil to the bearings, the engine may windmill as long as necessary provided the windmilling rpm is above 10 percent for at least 10 minutes and above 5 percent thereafter.

**TABLE VII**

**MODEL J47-7 AND -9**

**MINIMUM ACCEPTABLE PERFORMANCE RATINGS WITH SPEED (RPM) AND EXHAUST GAS TEMPERATURE LIMITS**

| Condition | Maximum Duration | Percent Military RPM | Engine Speed (rpm) | Minimum Acceptable Thrust (thrust lb) | Exhaust Gas Temperature Limit | Maximum Acceptable SFC (lb/hr/lb thrust) |
|---|---|---|---|---|---|---|
| Take-off | 5 minutes | 100 | 7950 | 5000 | 690°C (1275°F) max<br>675°C (1250°F) min | 1.130 |
| Military | 30 minutes | 100 | 7950 | 5000 | 690°C (1275°F) max<br>675°C (1250°F) min | 1.130 |
| Normal | Continuous | 92.7 | 7370 | 4250 | 654°C (1210°F) max | 1.061 |
| Cruise (89 Percent Normal) | Continuous | 82.5 | 6560 | 2930 | 654°C (1210°F) max | 1.056 |
| Minimum Cruise (84 Percent Normal) | Continuous | 77.9 | 6190 | 2300 | 654°C (1210°F) max | 1.088 |
| Idle | Continuous | *27.7 | 2200 | 290 (max) | 654°C (1210°F) max | ...... |
| Starting (Ground) | .... | ...... | .... | ....... | †870°C (1600°F) max | ..... |
| Transient (Accelerations) | ...... | .... | ....... | ........ | †870°C (1600°F) max | ...... |

*Minimum idle speed shall be at 25 percent military rpm.

†Exhaust gas temperature shall not exceed 715°C (1320°F) for more than 20 seconds.

## 1–68. ENGINE OPERATION.

**Note**

During all ground operation of engines equipped with an emergency fuel system, the emergency fuel system switch shall be in the "OFF" position except during a preflight check (paragraph 1–76) or in the event of main fuel system failure.

## 1–69. GROUND STARTING PROCEDURE.

**WARNING**

The danger areas around the air intake and jet exhaust must be clear of all personnel, aircraft, and vehicles before the engine is started. Suction at the air intake is sufficient to kill or seriously injure personnel by drawing them suddenly into or against the air intake. The high temperature and velocity of the jet exhaust is also extremely dangerous.

**CAUTION**

Whenever practicable, the aircraft should be on clean concrete or other paved surface when the engine is started and run up in order to minimize the possibility that dirt or other foreign material may be drawn into the engine compressor and cause serious damage to the engine.

**Note**

Auxiliary power equipment for ground starting should be checked for proper connections in accordance with the applicable instructions to insure that adequate power is available.

a. Be sure the throttle is fully closed.

b. Turn the aircraft fuel boost pump switch to "ON."

c. Turn the engine master switch to "ON."

d. Turn the starter and ignition switch to "ON."

**TABLE VIII**

**MODEL J47-11 AND -19**
**MINIMUM ACCEPTABLE PERFORMANCE RATINGS WITH SPEED (RPM) AND EXHAUST GAS TEMPERATURE LIMITS**

| Condition | Maximum Duration | Percent Military RPM | Engine Speed (rpm) | Minimum Acceptable Thrust (thrust lb) | Exhaust Gas Temperature Limit | Maximum Acceptable SFC (lb/hr/lb thrust) |
|---|---|---|---|---|---|---|
| Take-off | 5 minutes | 100 | 7950 | 5200 | 690°C (1275°F) max<br>675°C (1250°F) min | 1.13 |
| Military | 30 minutes | 100 | 7950 | 5200 | 690°C (1275°F) max<br>675°C (1250°F) min | 1.13 |
| Normal | Continuous | 96 | 7630 | 4730 | 654°C (1210°F) max | 1.071 |
| Best Cruise | Continuous | 88 | 7000 | 3700 | 654°C (1210°F) max | 1.030 |
| Cruise (89 Percent Normal) | Continuous | 85.4 | 6790 | 3350 | 654°C (1210°F) max | 1.032 |
| Minimum Cruise (84 Percent Normal) | Continuous | 80.6 | 6410 | 2705 | 654°C (1210°F) max | 1.056 |
| Idle | Continuous | *27.7 | 2200 | 290 (max) | 654°C (1210°F) max | .. |
| Starting (Ground) | ........ | ....... | ........ | ....... | †870°C (1600°F) max | |
| Transient (Accelerations) | ........ | ........ | ........ | ........ | †870°C (1600°F) max | .. |

*Minimum idle speed shall be at 25 percent military rpm.
†Exhaust gas temperature shall not exceed 715°C (1320°F) for more than 20 seconds.

CAUTION

Operation of the engine starter on all engine models is limited to 3 normal runs of one-minute maximum duration each during any 30-minute period.

On the J47-19 engine only, the starter can be actuated for 25 seconds with the engine rotor seized. This starter is limited to 2 such operations of 25 seconds each and one normal start of one-minute duration during any 30-minute period. This cycle may be repeated immediately during a second 30-minute period, but after the second cycle a one-hour cooling period is required before any further attempts are made to start the engine.

A restart may not be attempted under any conditions until the engine has come to a complete stop.

e. When the engine has reached 6 percent of rated rpm (9 percent for ground starts at altitudes above 4000 feet), open the throttle to obtain a fuel pressure of 30 to 35 psi (30 psi on J47-19 engines). This is equivalent to a fuel flow of 80 to 100 gph. When ignition occurs, as indicated by an increase in exhaust gas temperature, immediately retard the throttle to obtain a fuel pressure of 20 to 25 psi (fuel flow of 40 to 60 gph) and allow the exhaust gas temperature to stabilize.

WARNING

If ignition does not occur by the time engine speed has reached 9 percent rated rpm, or within 10 seconds for ground starts at altitudes above 4000 feet, close the throttle and open the starter and ignition switch by turning it to "OFF." Allow at least 3 minutes for complete fuel drainage before attempting another start.

Note

A starting fuel flow or fuel pressure which will permit consistent fixed-throttle starts may be found after accumulation of experience with a particular engine installation.

f. After the exhaust gas temperature has stabilized, advance the throttle carefully to maintain the exhaust

TABLE IX

MODEL J47-13 AND -15

MINIMUM ACCEPTABLE PERFORMANCE RATINGS WITH SPEED (RPM) AND EXHAUST GAS TEMPERATURE LIMITS

| Condition | Maximum Duration | Percent Military RPM | Engine Speed (rpm) | Minimum Acceptable Thrust (thrust lb) | Exhaust Gas Temperature Limit | Maximum Acceptable SFC (lb/hr/lb thrust) |
|---|---|---|---|---|---|---|
| Take-off | 5 minutes | 100 | 7950 | 5200 | 690°C (1275°F) max<br>675°C (1250°F) min | 1.130 |
| Military | 30 minutes | 100 | 7950 | 5200 | 690°C (1275°F) max<br>675°C (1250°F) min | 1.130 |
| Normal | Continuous | 92.7 | 7370 | 4320 | 654°C (1210°F) max | 1.042 |
| Best Cruise | Continuous | 88 | 7000 | 3700 | 654°C (1210°F) max | 1.030 |
| Cruise (89 Percent Normal) | Continuous | 82.5 | 6560 | 2960 | 654°C (1210°F) max | 1.043 |
| Minimum Cruise (84 Percent Normal) | Continuous | 77.9 | 6190 | 2330 | 654°C (1210°F) max | 1.086 |
| Idle | Continuous | †27.7 | 2200 | 290 (max) | 654°C (1210°F) max | ........ |
| Starting (Ground) | ........ | ........ | ........ | ........ | ‡870°C (1600°F) max | ........ |
| Transient (Accelerations) | ........ | ........ | ........ | ........ | ‡870°C (1600°F) max | ........ |

†Minimum idle speed shall be at 25 percent military rpm.

‡Exhaust gas temperature shall not exceed 715°C (1320°F) for more than 20 seconds.

gas temperature at approximately 600°C (1112°F) while accelerating the engine to idle speed. On the J47-19 engine, keep the exhaust gas temperature below 500°C (930°F) while accelerating to idle speed.

**CAUTION**

If the exhaust gas temperatures during starting exceed the limits specified in paragraphs 1—66 and 1—67, the engine must be shut down and carefully inspected before flight, and appropriate action must be taken in accordance with the instructions given in paragraph 1—67. If normal care is exercised during the starting procedure, satisfactory starts can be made consistently without exceeding exhaust gas temperatures of 650°C (1202°F).

If there is no indication of oil pressure by the time 80 percent rpm is reached, or within 60 seconds of starting, shut down the engine and investigate the cause. Refer to table VI for oil pressure limits.

1—70. ENGINE RUN-UP.

**Note**

Engines should be run up with the aircraft headed into or at right angles to any ground winds, since a tailwind blowing into the jet nozzle may increase the exhaust gas temperature.

a. Normally, the throttle may be slowly advanced to full-open as soon as the engine stabilizes at idling speed. Careful checks should be made during this time to insure satisfactory engine operating conditions and to avoid exceeding an exhaust gas temperature of 690°C (1275°F). (See paragraph 1—71 for the procedure for checking lube oil pressure.

**Note**

Rapid acceleration to 100 percent rpm on cold engines usually results in the exhaust gas temperature overshooting the maximum allowable 690°C (1275°F).

b. If the maximum allowable exhaust gas temperature of 690°C (1275°F) is reached at engine speeds below 100 percent rpm, the engine should be held at the lower speed until the exhaust gas temperature is stabilized sufficiently to permit further increase in speed without exceeding the maximum allowable exhaust gas temperature. (Refer to paragraph 1—66.)

**Note**

On some engines, operation between 96 and 100 percent rpm may be required for approximately 5 to 10 minutes to permit full stabilization of the exhaust gas temperature before 100 percent rpm can be reached.

1—71. CHECKING LUBE OIL PRESSURE. If no rise in lube oil pressure occurs by the time idle rpm has been reached, increase engine rpm until a definite rise is apparent. If the lube oil pressure does not rise within 60 seconds or by the time 80 percent rpm is reached, shut down the engine and investigate the lube oil system. During cold weather operation, lube oil pressure may exceed maximum limits until the lube oil temperature becomes normal. Refer to paragraph 1—62 and table VI.

1—72. ACCELERATION PRECAUTIONS. During ground or flight operation, make accelerations by changing the throttle position as slowly as practicable, in order to minimize strain on hot parts of the engine and to prevent compressor pulsation or stall or combustion flameout. Throttle bursts may be made on engines with VS-2 Model G5, G6, or later model main fuel regulators only. Refer to paragraph 1—74 for throttle burst checking procedure.

**CAUTION**

Rapid throttle advance must not be made when the emergency fuel system is operating (J47-7, -9, and -13 engines). Serious overtemperature and stall may result.

a. Compressor stall may result from too rapid an acceleration, especially in an acceleration from below minimum cruise rpm. Rapid advance of the throttle supplies too much fuel to the combustion chambers. The expanded gases can not flow through the turbine nozzle fast enough so the increased pressure in the combustion chambers backs up, raising the compressor discharge pressure, thus restricting the normal flow of compressed air from the compressor. The "stall" is actually a marked decrease of compressor discharge air flow into the combustion chambers. The increased compressor discharge pressure slows down the compressor rotor, reducing the fuel flow which in turn lowers the compressor discharge pressure. Normally equilibrium is rapidly reached and the engine may operate in stall at 65 or 75 percent rpm.

**Note**

Most stalls will be encountered in the region of 65 to 75 percent rpm.

b. It is possible to encounter compressor stall without making a throttle movement. At low engine speed, 60 to 65 percent rpm, plane maneuvers that reduce the inlet duct efficiency may cause a mild stall.

c. Two types of stalls may be encountered, severe and mild. Severe stalls, are accompanied by minor detonations, severe engine vibration, and a rapid increase in exhaust gas temperature resulting in overtemperature condition. Mild stalls are harder to recognize. The only immediate indication of the stall is a "hang up" of engine speed at 65 to 75 percent rpm with the throttle at "MILITARY." A brief observation of the temperature indicator may not detect the gradual rise of exhaust gas temperature.

**CAUTION**

Immediately retard the throttle to "IDLE" whenever the conditions constituting stall occur. When the exhaust gas temperature returns to normal, make a slow acceleration to the desired rpm.

d. When the engine is operating on the emergency fuel system (J47-7, -9, and -13 engines), a stall due to a rapid throttle advance or throttle burst produces a much more serious condition than a stall when operating on the main fuel system. The emergency system schedules fuel flow by throttle position and compressor inlet pressure. Consequently the amount of fuel immedately introduced by a throttle burst on the emergency system is the amount needed to operate the engine at the new throttle setting and is much greater than the amount of fuel introduced by a throttle burst on the main fuel system. This condition is extremely serious because so much fuel is introduced that an overtemperature condition and possibly an explosion will occur before the pilot or operator realizes the stall condition exists.

**CAUTION**

In the event of a main fuel system failure in which the rpm is dropping off with the throttle at "MILITARY", retard the throttle to "IDLE" before switching from the main fuel system to the emergency system. If the throttle is not retarded, the effect will be that of a throttle burst on the emergency fuel system resulting in a compressor stall which may not be recognized as such since the engine is already malfunctioning at the time of the switchover.

e. Combustion flameout during acceleration at altitudes above 25,000 feet may result from too rapid a throttle advance. Combustion flameout is indicated by loss of thrust, decrease in exhaust gas temperature, engine deceleration, or possible loud noises similar to the backfire from a reciprocating engine. Recovery may be made by closing the throttle and making an altitude restart.

1–73. DECELERATION PRECAUTIONS. Flameout during deceleration may be encountered if the throttle is retarded to below the idle rpm stop position. Recovery may be accomplished by making a normal restart.

1–74. THROTTLE BURST CHECK. On engines with VS-26900G5, G6, or later model main fuel regulators, make a throttle burst check as follows to check for proper fuel scheduling.

a. Set the throttle at the idle rpm for one to 2 minutes.

**CAUTION**

Make sure the emergency fuel system switch is "OFF" on engines equipped with emergency fuel systems.

b. Advance the throttle rapidly to the full open position. A satisfactory acceleration should result.

**CAUTION**

If the engine rpm stops increasing, or other symptoms of compressor pulsation or stall (paragraph 1–72, step "a") are present, immediately retard the throttle to prevent damage to the engine.

1–75. JET NOZZLE AREA ADJUSTMENT. Connect the Jetcal tester as described in the applicable service handbook. (Refer to paragraph 1–55B.) Use the potentiometer of the Jetcal tester for all temperature readings during the following adjustment procedures. Run up the engine as described in paragraph 1–70. After the exhaust gas temperature has stabilized, record the stabilized temperature. If engine operation is not within the limits of step "a," below, shut down the engine and allow the exhaust area to cool sufficiently to permit adjustment of the jet nozzle area. Adjust the jet nozzle area to maintain the exhaust gas temperature as close to 675°C (1245°F) as possible. This will allow some margin for exhaust gas temperature increase resulting from variation in the compressor inlet temperature, without exceeding the maximum allowable limit of 690°C (1275°F). Run up the engine after adjustment to ensure that the exhaust gas temperature is within limits.

**Note**

A change of one square inch in jet nozzle area will result in a change of approximately 7°C (12.6°F) in exhaust gas temperature.

a. If 100 percent rpm can be reached after full stabilization of the exhaust gas temperature at 675 to 690°C (1245 to 1275°F), adjustment of the jet nozzle area is not required.

b. If the exhaust gas temperature is stabilized at below 675°C (1245°F), decrease the jet nozzle area in order to increase the exhaust gas temperature range to the range specified in step "a" above.

c. If the exhaust gas temperature is above 690°C (1275°F), increase the jet nozzle to lower the temperature to the specified range.

d. If the exhaust gas temperature is above 690°C (1275°F) and the jet nozzle area cannot be increased to lower the temperature to the specified range, operate the engine at a speed between 96 and 100 percent rpm so that the maximum exhaust gas temperature is not exceeded. Rated take-off and military thrust are available during operation at speeds between 96 and 100 percent rpm with the exhaust gas temperatures between 675 and 690°C (1245 and 1275°F).

1–76. EMERGENCY FUEL SYSTEM PREFLIGHT OPERATIONAL CHECK. The emergency fuel system preflight operational check should be made on all engines which incorporate an emergency fuel system, except for those used in multi-engine installations. This check should be made just prior to take-off.

a. With the emergency fuel system switch "OFF," run up the engine to top rated speed on the main fuel system to make sure that 100 percent rpm is available.

b. Decelerate the engine to 80 percent rpm.

c. Hold the emergency fuel system switch in the "TEST" position and advance the throttle until it hits the stop. The maximum speed available should be 99 percent rpm or slightly below, and must be within 2 percent of the curve shown in figure 4—16. If necessary, adjust the control linkage to obtain the correct engine rpm on the emergency fuel system. (Refer to paragraph 4—96, step "l.")

d. Return the emergency fuel system switch to the "OFF" position and allow engine rpm to stabilize. If the stabilized engine speed is over 101 percent rpm, adjust the main fuel system high speed stop on the No. 4 island cover. (Refer to paragraph 4—94, step "h.")

e. Return the emergency fuel system switch to the "TEST" position and note the recovery time. Recovery time is measured from the instant the emergency fuel system switch is moved to "TEST" up to the instant that fuel pressure starts to increase. Recovery time should be 3 seconds or less. If recovery time is greater than 3 seconds, the emergency fuel regulator must be replaced (paragraphs 4—87 and 4—88) or modified as necessary in accordance with paragraph 4—86.

f. Return the emergency fuel system switch to the "OFF" position.

**Note**

A drop to approximately 90 percent rpm with an immediate recovery to full rpm may occur when switching the emergency system switch from "TEST" to "OFF." This drop-off and recovery is normal and indicates the emergency fuel regulator has been closed out of the system.

1—77. ENGINE OPERATION DURING AIRCRAFT TAXIING. The following precautions should be observed during aircraft taxiing:

a. Make any required engine speed changes by changing throttle position slowly. Throttle bursts are unnecessary and should be avoided.

b. Maintain engine speed as low as practicable to conserve fuel.

1—78. EMERGENCY FUEL SYSTEM OPERATION DURING TAKE-OFF, CLIMB, AND FLIGHT.

**CAUTION**

Failure to keep the emergency fuel system switch in the "OFF" position except during take-off and initial climb will result in it being impossible to accomplish rapid throttle movements without the emergency fuel system overriding the main fuel system.

a. The emergency fuel system switch should be moved to the "ON" position after the engine speed has reached 80 percent rpm or above during engine run-up. If it becomes necessary to retard the throttle for any reason prior to take-off or during initial climb, and less than 80 percent rpm results, the emergency fuel system switch must be returned to the "OFF" position or the throttle must be moved very slowly when it is again advanced. When a safe altitude has been reached, the switch should always be at the "OFF" position.

**CAUTION**

Care must be used to avoid overspeeding whenever the emergency fuel system is in use, since engine speed is controlled manually by the throttle.

b. In the event of main fuel system failure during normal flight when the emergency fuel system switch is "OFF," the flame will be lost in approximately 3 seconds. The decision whether to use the emergency fuel system or to attempt an altitude restart must therefore be made immediately. If the throttle is wide open, the emergency fuel system switch must be turned "ON" before engine speed drops below 80 percent rpm. If engine speed is below 80 percent rpm, however, the throttle must be retarded to idle speed before the switch is turned "ON." The throttle must then be advanced cautiously to prevent possible serious overtemperature and stall.

**CAUTION**

Rapid throttle advance must not be made when the emergency fuel system switch is "ON."

1—78A. FLIGHT IDLE.

a. Flight idle is an engine speed from which a throttle burst acceleration to maximum rpm can be made with probable freedom from stall. The flight idle percent rpm does not correspond with sea level idle percent rpm nor does it usually coincide with the "IDLE" detent position on the quadrant. Refer to table IX-A for minimum flight idle.

**CAUTION**

Throttle burst accelerations attempted from engine speeds below flight idle at altitudes above 20,000 feet will be slow and will probably result in a compressor stall.

b. Minimum operating idle rpm is the engine speed with the throttle in the "IDLE" detent position. The minimum operating idle rpm will increase with the altitude.

**TABLE IX-A**

**FLIGHT IDLE RPM**

| Altitude (feet) | Percent RPM |
|---|---|
| 10,000 | 35 |
| 20,000 | 45 |
| 30,000 | 65 |
| 40,000 | 75 |

1—79. ENGINE RESTART PROCEDURE DURING FLIGHT. Altitude restarts should not be attempted at altitudes above 20,000 feet when using fuel conforming to Specification MIL-F-5616, or above 30,000 feet when using fuel conforming to Specification MIL-F-5624A. Restarts above these altitudes may result in turbine rotor shroud ring seizure because of incomplete flame propagation to all combustion chambers.

**CAUTION**

All restarts should be made at minimum safe airspeeds.

a. The throttle should be fully closed immediately upon loss of power. If sufficient altitude is available, the aircraft should be kept as level as possible for at least 5 seconds to allow purging of the engine and drainage of any fuel accumulation.

b. After fuel has drained, the altitude and test ignition switch should be turned "ON" and the throttle should be rapidly opened to obtain a fuel pressure of 25 to 30 psi (equivalent to a fuel flow of 60 to 80 gph). The throttle should be maintained in this position until ignition occurs.

**Note**

If ignition does not occur within 20 seconds after opening the throttle, the throttle should be slowly retarded to reduce fuel pressure to 20 psi (fuel flow of 40 gph), advanced to increase fuel pressure ro 35 psi, and again retarded to reduce pressure to 20 psi. This cycle should be repeated until ignition occurs or until a total of 60 seconds has elapsed. If ignition still does not occur, the throttle should be fully closed and another start attempted after engine purging and fuel drainage.

If fuel pressure or flow is not obtained in an attempted restart on the main fuel system, the procedure should be repeated on the emergency fuel system (J47-7, -9, and -13 engines only).

c. When ignition occurs, as indicated by an increase in exhaust gas temperature, fuel pressure should be maintained at 25 to 30 psi (fuel flow of 60 to 80 gph) until the exhaust gas temperature begins to stabilize. The throttle may then be advanced to increase fuel pressure and flow as required to maintain the exhaust gas temperature between 450 and 500°C (832 to 932°F) until normal idle rpm for the altitude is obtained. (Refer to paragraph 1—78A.)

d. After normal idle rpm is obtained, the altitude and test ignition switch should be turned "OFF." Normal operating procedure is then used in accelerating to the desired engine speed.

1—80. ENGINE OPERATION UNDER ICING CONDITIONS. Since these engines do not have anti-icing equipment, a careful check should be kept when operating under known icing conditions. Icing can occur in the engine air inlet section even though no external evidence of icing is visible. Initial symptoms of engine icing are a decrease in thrust and an increase in tailpipe temperatures. When the tailpipe temperature begins to increase under icing conditions, an effort should be made to leave the icing area.

**CAUTION**

If the throttle is advanced in an effort to maintain thrust, the turbine section and exhaust cone will become hotter and engine failure may occur very rapidly.

1—81. ENGINE STOPPING PROCEDURE.

a. Slowly retard the throttle to the 70 percent rpm position. Hold the throttle for one to 3 minutes at 70 percent rpm and then close it rapidly to the idle cut-off (full closed) position. Combustion will cease immediately, exhaust gas temperatures will drop rapidly, and the engine should coast to a stop. The short holding period at 70 percent rpm will permit the engine to scavenge the lube oil system properly, and will minimize possible shroud rub.

**Note**

If it is impractical to utilize 70 percent rpm prior to shutdown, the minimum requirement is one to 3 minutes at idle rpm.

**CAUTION**

In emergencies only, the engine may be stopped from any speed by retarding the throttle immediately to the idle cut-off position.

b. Turn the engine master switch "OFF."

c. Turn the aircraft fuel boost pump switch "OFF."

# SECTION II

## SPECIAL SERVICE TOOLS

| Tool No. | Nomenclature and Application | Figure No. |
|---|---|---|
| 1C686 | Eye—Engine Lifting | 2—3 |
| 1C984 | Gage—Exhaust Cone to Turbine Wheel Clearance | 4-9 |
| 1C988 | Clamp—Combustion Chamber Bellows Compressing | 2—1 |
| 1C989 | Clamp—Combustion Chamber Bellows Expanding | 2—2 |

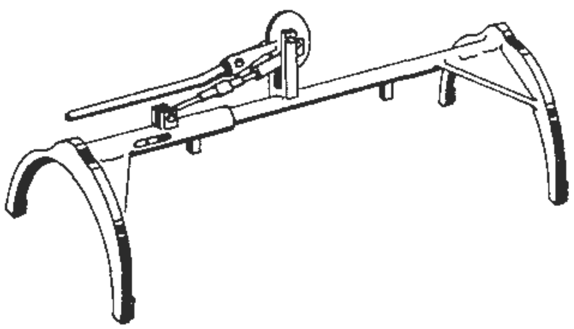


*Figure 2—1. Combustion Chamber Bellows Compressing Clamp*

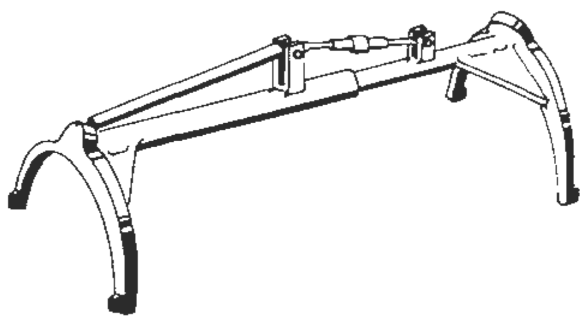


*Figure 2—2. Combustion Chamber Bellows Expanding Clamp*

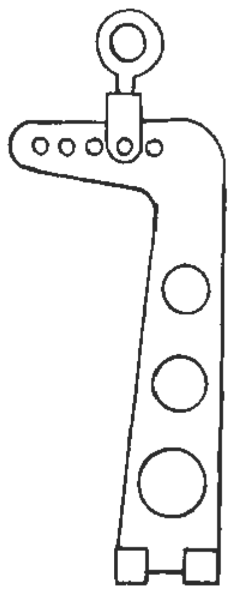


*Figure 2—3. Engine Lifting Eye*

# SECTION III

# PERIODIC INSPECTION AND LUBRICATION

## 3—1. GENERAL.

3—2. The inspection and lubrication procedures prescribed in this section are a normal function of the operational service organization. All work should be done thoroughly to achieve satisfactory engine operation and performance.

## 3—3. SAFETY PRECAUTIONS.

3—4. REASON FOR PRECAUTIONS. After operation of a turbojet engine on leaded fuel (gasoline containing tetraethyl lead), a yellow powdery residual deposit may be found on the surfaces of parts which are exposed to the combustion and exhaust gases. Service personnel must observe certain safety precautions when working on engines that use leaded fuels, since the yellow deposits contain lead which may cause lead poisoning if it is inhaled into the lungs or swallowed in sufficient quantities.

3—5. PRECAUTIONS.

**WARNING**

The following precautions must be observed by all personnel.

a. Safeguard open cuts and sores from possible contamination.

b. Avoid spreading the particles of lead deposit into the air. Provide ample ventilation.

c. To avoid passing lead into the mouth, wash the hands thoroughly with soap and water before eating food or candy or using tobacco.

d. Do not inhale fumes or dust containing particles of lead residue. Do not touch the nasal passages with contaminared fingers.

## 3—6. PERIODIC INSPECTION.

3—7. INSPECTION REQUIREMENTS. Table X lists the required periodic inspections. The parts to be inspected are listed in alphabetical order in the first column of the table. All inspections listed in the second column are mandatory and must be performed at the times listed in the third column of the table.

3—8. PREFLIGHT INSPECTION. The items listed in the third column of table X for the preflight inspection shall be inspected before every flight and before any ground operation.

3—9. POSTFLIGHT INSPECTION. The items listed in table X for the postflight inspection shall be inspected after every flight and after every operation on the ground. In addition to the regular periodic postflight inspection specified in table X, the overtemperature inspection given in paragraph 3—14 shall be performed whenever the engine has been subjected to overtemperature operation as specified in paragraph 1—67.

3—10. 50-HOUR INSPECTION. The items listed in table X for the 50-hour inspection shall be inspected on both new and overhauled engines after each 50 hours of operation. If the engine is not entirely accessible, it shall be removed from the aircraft or nacelle for the 50-hour inspection. After the 50-hour inspection, the engine shall be operated in accordance with paragraph 3—12.

3—11. 100-HOUR INSPECTION. The items listed for the 100-hour inspection shall be inspected on both new and overhauled engines after every 100 hours of operation. The 100-hour inspection shall also be performed whenever the engine has been subjected to a loading of 10 "G" or more. If the engine is not entirely accessible, it shall be removed from the aircraft or nacelle for the 100-hour inspection. After the 100-hour inspection, the engine shall be operated and checked in accordance with paragraph 3—12.

3—12. POST-INSPECTION OPERATIONAL CHECKS. Upon completion of either the 50-hour or 100-hour inspections, the engine shall be operated and the following checks made:

a. Control settings and all engine systems shall be checked for satisfactory operation. The Jetcal tester shall be used to check the exhaust gas temperature indication system as described in the applicable service handbook. (Refer to paragraph 1—55B.) Generator output and fuel and oil pressures must be normal, and the exhaust gas temperatures must be within limits.

b. Drain valves shall be checked for satisfactory operation. The operation of the drip valves shall be checked at idle rpm.

**Note**

After several minutes of operation at idle rpm, little or no leakage should appear from the drip valves.

c. On engines equipped with a No. VS-26900G5, G6, or later model main fuel regulator, the throttle burst check specified in paragraph 1—74 shall be performed.

d. On shutdown, the engine shall be checked for unusual turbine noises. Refer to table XI.

## 3—13. OVER-LIMITS INSPECTIONS.

3—14. OVERTEMPERATURE. The following components shall be inspected if the engine is subjected to overtemperature operation as defined in paragraph 1—67, step "b." Operation at temperature exceeding the

limits given in paragraph 1–67, steps "a" and "c," requires that the engine be returned to an approved AMC activity for replacement of the turbine wheel prior to the next flight.

a. Exhaust cone (paragraph 4–30).

b. Turbine shroud ring (table X).

c. Turbine buckets (paragraph 4–36).

d. Outer and inner combustion chambers (paragraphs 4–17 and 4–18).

e. Inner and outer cross-ignition tubes (table X).

f. Transition liners (paragraph 4–20).

g. Turbine nozzle partitions (paragraph 4–22).

3–15. LOADING IN EXCESS OF 10 "G." The components listed in table X for the 100-hour periodic inspection shall be inspected whenever the engine has been subjected to a loading of 10 "G" or more.

3–15A. INSUFFICIENT OIL SUPPLY. If the engine has been operated with an insufficient oil supply, but within the acceptable limits described in paragraph 1–67A, perform the following inspection prior to the next flight:

a. Run-up the engine to idle rpm for 10 minutes and check for excessive vibration. Refer to paragraphs 1–69 and 1–70 for starting and run-up instructions.

b. Shut down the engine, allow it to cool, and inspect for the presence of metal chips in the lube oil filter, finger screens, and magnetic plug. Refer to paragraph 1–81 for engine stopping procedure.

c. If excessive vibration is encountered or metal chips are present, return the engine to an approved AMC activity for overhaul.

## 3–16. LUBRICATION.

3–17. The oil tank level shall be checked after the postflight inspection is performed. Any necessary additions of lubricating oil shall be made at this time. Refer to table IV for lube oil specifications.

## TABLE X

## PERIODIC INSPECTION

| Component | Nature of Inspection | Inspection Time |
|---|---|---|
| Accessory Drive Gear Box | Remove magnetic drain plug from bottom of accessory drive gear box and inspect oil for metal chips.<br><br>**CAUTION**<br><br>Wipe off all excess oil. Be careful to prevent oil from entering the compressor air inlet. | 50-hour<br>100-hour |
| Air Guide | Check for foreign objects and for loose or missing fasteners on the island guide assemblies. | Preflight<br>Postflight<br>50-hour<br>100-hour |
| | Check for loose or missing rivets. | Postflight<br>50-hour<br>100-hour |
| Air Inlet Screens | Check for broken screens and loose or missing screen fasteners. | Preflight<br>Postflight<br>50-hour<br>100-hour |
| Combustion Chamber Drain Lines and Fittings | Inspect for cracks or ruptures. | 50-hour<br>100-hour |
| Combustion Chamber Marman Clamps | Inspect for distortion, weld failures, and stripped bolts. Replace stripped "T" bolts and damaged clamps. | 100-hour |
| Compressor Blades | Check all visible or accessible compressor blades for damage. Refer to paragraphs 4—9 through 4—12. | Preflight<br>Postflight<br>50-hour<br>100-hour |
| Compressor Front and Rear Frames | Check compressor rear frame air vent ports for aluminum dust which indicates excessive rubbing of compressor twelfth-stage air seals.<br><br>**Note**<br><br>A light coating of low temperature grease placed on the surface of the fuselage or nacelle immediately aft of the compressor rear frame vent duct outlet will aid in retaining any aluminum dust. | Postflight<br>50-hour<br>100-hour |

TABLE X (Cont)

| Component | Nature of Inspection | Inspection Time |
|---|---|---|
| Compressor Front and Rear Frames (Cont) | Remove drain plug from compressor rear frame lube oil sump and check drained oil for dirt or chips, excessive metallic powder, and silicone gasket particles. | 50-hour<br>100-hour |
| | Inspect forward and rear flange fillets and support pad fillets for cracks. Cracks are not allowable and require that the engine be returned to an approved AMC activity. | 100-hour |
| | Remove fuel nozzles (paragraph 4–92) and inspect compressor rear frame cabin take-off ports according to the instructions in paragraph 4–14. | 100-hour |
| Compressor Stator Casing | Inspect front and rear flange fillets for cracks. Cracks are not allowable and require that the engine be returned to an approved AMC activity. | 100-hour |
| | Loosen and retorque all nuts and bolts on horizontal and vertical flanges to the specified values (Reference No. 32 through 35, table XVII). | 100-hour |
| Cooling and Balance Air Tubing and Hoses | Check for damage and see that hose clamps are secure. | 50-hour |
| Double Check Valve (Except J47-11, -15, and -19) | Inspect for defective or worn seals or broken hinge straps. | 100-hour |
| Exhaust Cone | Check for damage and location of possible hot spots. | Postflight<br>50-hour<br>100-hour |
| | Remove and inspect according to the instructions in paragraphs 4–28 through 4–32. | 50-hour<br>100-hour |
| Exhaust Cone Marman Clamp | Inspect spot weld and fillet weld areas. Cracks are not allowable, and require replacement of clamp. | 50-hour<br>100-hour |
| Fuel Control Linkage | Check for correct adjustment, freedom of operation, and full travel. Refer to paragraphs 4–93 through 4–97. | Post-flight<br>50-hour<br>100-hour |
| Fuel Filter | Remove and clean. Refer to paragraphs 4–71 through 4–75. Check for brass particles. | 50-hour<br>100-hour |
| Fuel Nozzles | Check nozzle tips for excessive carbon formation, noting location of any hot spots on exhaust cone. Replace any nozzles which have unbalanced fuel flow. Refer to paragraph 4–92. | 100-hour |
| Fuel System Lines and Accessories | With boost pump operating, check for leaks. Check for loose connections and mountings and excessive chafing of lines. | Postflight<br>50-hour |
| Hydraulic Pump Drive Gear Case (J47-7 and -13 Only) | Check the oil level. | Postflight<br>50-hour<br>100-hour |
| Igniter Plugs | Remove, clean, and inspect igniter plugs according to the instructions in paragraphs 4–48 and 4–49. Replace if necessary. | 50-hour<br>100-hour |
| Ignition Leads | Check flexible leads for fraying, deterioration, or other damage, and replace if necessary. | 50-hour<br>Postflight |

TABLE X (Cont)

| Component | Nature of Inspection | Inspection Time |
|---|---|---|
| Ignition System | Check operation by energizing and listening for steady buzzing sound from igniter plugs. | 50-hour<br>100-hour |
| Inner Combustion Chambers | Inspect as instructed in paragraph 4–18 after performing the inspection of outer combustion chambers.<br>**Note**<br>Do not remove inner combustion chambers unless inspection shows that replacement is necessary. | 100-hour |
| Inner Cross-ignition Tubes | Remove inner cross-ignition tubes (paragraph 4–16, step "c") and inspect for cracks and burning. Replace if any cracks are found or if burning has caused a reduction in the thickness of the metal. | 100-hour |
| Lube System Lines and Accessories | Check for leaks, loose connections and mountings, and excessive chafing of lines. | Postflight<br>50-hour<br>100-hour |
| Main Lube Filer | Remove and clean. Refer to paragraphs 4–63 through 6–67. Check for powdered aluminum. | 50-hour<br>100-hour |
| Oil Cooler | Remove drain plug and note condition of drained oil. Replace plug and lock with safety wire. | 50-hour |
| Outer Combustion Chambers | Inspect visually for cracks or ruptures adjacent to the front and rear drain fittings. Pay particular attention to the No. 1, 2, 7, and 8 chambers in the vicinity of front drain fittings. | 50-hour<br>100-hour |
| | Inspect as specified in paragraph 4–17. | 100-hour |
| Outer Cross-ignition Tubes | Inspect for leakage around gaskets and bellows and replace if necessary. (Refer to paragraph 4–16.) Inspect for cracks and replace if any are found. The bellows adjacent to the seam weld and the tabs are particularly susceptible. | 50-hour<br>100-hour |
| Regulator Oil Filter and Orifice | Remove and clean. Refer to paragraphs 4–58 through 4–67. Check for powdered aluminum. | 50-hour<br>100-hour |
| Scavenge Oil Filter | Remove scavenge oil lube tube assembly from the bottom of the forward end of the turbine frame and clean the internal scavenge oil filter. | 100-hour |
| Starter-generator or Starter | Check surface of power take-off assembly around starter-generator cooling air duct or starter commutator for brush-carbon dust. Inspect brushes if an appreciable amount of brush-carbon dust is found. | Postflight<br>50-hour |
| | Inspect brushes for wear and replace brushes worn to within 1/8 inch of the pigtail rivets. Inspect commutator for proper film. Replace starter-generator or starter if commutator is excessively scored or pitted. Refer to paragraph 4–38. | 100-hour |
| Starter-generator Cooling Air Duct | Check for security of mounting. | Postflight<br>50-hour<br>100-flight |
| Thermocouple Harness | Check braid insulation for damage, especially near or under brackets. Check for shorted or open circuits. Check for a minimum resistance of 500 ohms between conductors and ground. | Postflight<br>50-hour<br>100-hour |

TABLE X (Cont)

| Component | Nature of Inspection | Inspection Time |
|---|---|---|
| Transition Liners | With combustion chambers removed (paragraph 4—16), inspect transition lines according to the instructions in paragraph 4—20. | 100-hour |
| Turbine Nozzle Diaphragm | Inspect according to the instructions in paragraphs 4—22 and 4—23. | 50-hour<br>100-hour |
| Turbine Rotor | Listen during shutdown for sounds of rubbing which indicate interference between rotating and stationary parts. Check for damaged or missing buckets. | Postflight |
| | With exhaust cone removed (paragraph 4—29), inspect rotor wheel for scoring. Refer to paragraph 4—25. | 50-hour<br>100-hour |
| | Inspect turbine buckets and repair as required according to the instructions in paragraph 4—26 and 4—27. | 50-hour<br>100-hour |
| Turbine Shroud Ring | With exhaust cone removed (paragraph 4—29), inspect shroud ring for damage or distortion. Check turbine bucket tip to shroud ring clearance according to the instruction in paragraph 4—32.<br><br>**CAUTION**<br><br>Do not remove the shroud ring unless it is damaged or the clearances do not meet specified limits. The shroud ring may become distorted during removal, preventing reassembly. | 50-hour<br>100-hour |

# SECTION IV
# MAINTENANCE

## 4–1. GENERAL.

4–2. The procedures outlined in this section are those required to maintain the engine in satisfactory operating condition, and those indicated during the course of periodic inspection. Trouble-shooting procedures and remedies are also provided for service personnel. No major overhaul work will be performed by service personnel.

**WARNING**

Observe all safety precautions given in paragraphs 3–3 through 3–5 concerning the lead residue of the engine fuel.

4–3. When removal and reinstallation of the engine is necessary, refer to the appropriate erection and maintenance handbook for the particular aircraft.

## 4–4. TROUBLE SHOOTING.

4–5. DISCOVERING TROUBLES. Any improper functioning of the engine may be classified according to 2 general types: those troubles such as the engine failing to start, that are at once obvious, and other troubles that are not obvious but can cause considerable damage to the engine if not discovered in time. In order to detect the less obvious troubles as soon as they occur, the service mechanic must have a thorough knowledge of correct exhaust gas temperature, fuel pressure, lube oil pressure, and the other important details of normal engine operation. This information is presented in paragraphs 1–56 through 1–67.

4–6. ISOLATING TROUBLES. Engine troubles are not always traceable to one cause. Starting first with the most probable reasons for a trouble, the mechanic should check each possibility in turn until the trouble has been isolated by process of elimination. Even a thoroughly experienced mechanic should not jump to conclusions. Systematic diagnosis should replace guesswork in order to promote accuracy and to save time. It is best never to assume anything when trouble shooting. Leaks and defective wiring should always be kept in mind as possible causes of troubles.

4–6A. ISOLATING TROUBLES IN EXHAUST GAS TEMPERATURE INDICATION SYSTEM. In the event of engine temperature troubles, the first step in isolating the trouble is check the accuracy of the thermocouple harness and exhaust gas temperature indicator using the Jetcal tester. (Refer to paragraph 1–55B.) Once it is determined that the exhaust gas temperature indication system is accurate and free of trouble, continue the search for the trouble as outlined in table XI.

**Note**

Refer to the applicable service handbook for the Jetcal tester operating instructions.

4–7. CORRECTING TROUBLES. The service mechanic should correct the trouble as carefully and efficiently as possible. If he discovers the trouble is traceable to one of the accessories, such as a fuel or lube pump, he should not hesitate to replace it. Table XI lists the more common engine troubles, their probable causes, and their corrections.

**TABLE XI**
**ENGINE TROUBLES AND THEIR REMEDIES**

| Trouble | Probable Cause | Correction |
|---|---|---|
| Insufficient or no rpm when attempting to start engine. | 1. If rotor can be turned freely, the trouble can be assumed to be electrical. | |
| | a. Faulty external power source or faulty connections. | Check output of power source and its connections. Repair or replace as required. |
| | b. Circuit breakers in aircraft's electrical system open. | Close circuit breakers. If circuit breakers continue to open, check electrical system to locate cause of overloading. |
| | c. No power to starter-generator (or starter) terminals. | Check voltage at No. 1 island. If no voltage, refer to aircraft's technical orders for electrical system troubles and remedies. |
| | d. Starter-generator (or starter) leads reversed. | Check and reconnect if necessary. |
| | e. Starter-generator (or starter) grounded, open, short-circuited, or seized. | Replace starter-generator (or starter) (paragraph 4–38). |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Insufficient or no rpm when attempting to start engine. (Cont) | f. Starter-generator (or starter) brushes: | |
| | Improperly fitted | Reseat brushes. |
| | Sticky or defective | Replace brushes. |
| | Terminal screws loose | Tighten screws. |
| | Insufficient spring tension | Replace starter-generator (or starter) (paragraph 4–38). |
| | 2. If power from the external source is not faulty, and starter-generator (or starter) is straining to turn engine rotor, trouble is mechanical. | |
| | a. Icing in compressor. | Direct hot air into compressor. |
| | b. Shroud ring seizure. | Allow the engine to cool. If the seizure was caused by too sudden a shut-down at previous operation, or by any other condition which resulted in quick cooling of the shroud ring, allowing the engine to cool should eliminate the trouble. After cooling, turn the turbine wheel with a pole or with shop air directed through the compressor air inlet. If shroud still rubs, check bucket tip clearance (paragraph 4–32). |
| Combustion does not occur during an attempted start. | 1. If fuel pressure is normal for starting (20 to 40 psi), listen for firing of igniter plugs. | Investigate ignition system. Whenever possible (as in step "a" below), use a voltmeter, turning on flow of current with altitude or test ignition switch. |
| | a. If firing of igniter plugs is heard. | Check ignition relay solenoid for proper operation. |
| | b. If no igniter plug firing is heard. | Check cables leading to ignition units (or transformers) for current. Also check items "c" through "f" below. |
| | c. Voltage from main junction box. | Voltage should check at 24V. |
| | d. Dirty or defective igniter plugs. | Remove, clean, and inspect igniter plugs (paragraphs 4–48 and 4–49). Replace if necessary. |
| | e. Igniter plug leads (high voltage cables) grounded or broken. | Be sure leads are full of Dow Corning compound, or equivalent, and not shorted. |
| | f. Ignition units (or transformers) defective. | Replace (paragraph 4–42 or 4–44) if the above steps have not located the trouble. |
| | 2. If checks show that ignition system is in order and that fuel pressure at starting rpm is normal, the trouble is probably a faulty spray pattern. | Install replacement fuel nozzles (paragraph 4–92) in the No. 2 and 7 combustion chambers (No. 3 and 7 for J47-19 only). Attempt to start the engine. If replacement nozzles give a correct spray pattern, the trouble is probably elsewhere. |
| | 3. If fuel pressure is low or there is no fuel pressure, and the igniter plugs can be heard firing, the trouble is in | |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Combustion does not occur during an attempted start. (Cont) | the fuel system. If the start was attempted with both the main and emergency systems operating (except J47-11,-15, and -19), the trouble must be somehing common to both systems. | |
| | a. Fuel supply and boost pump defective. | Check items "a," "b," and "c" by breaking fuel line at No. 3 island and operating the boost pump. |
| | b. Aircraft-mounted fuel filter and bypass valve clogged. | Check and replace if necessary. |
| | c. Aircraft-mounted selector or shut-off valve not fully open. | Set valve in open position and check operation. |
| | d. Clogged fuel lines. | Locate and clear. |
| | e. Stopcock or stopcock control linkage defective or misadjusted. | Check by disconnecting fuel line at oil cooler, operating boost pump with throttle open, and turning engine at 3 to 4 percent rpm with starter. If no fuel appears, check stopcock control linkage (paragraph 4—94). If necessary, replace stopcock (paragraphs 4—77 and 4—78). |
| | f. Flow divider improperly adjusted or stuck open. | Remove large slot fuel manifold connection from flow divider outlet and cap the line and the outlet. If the engine can now be started, replace flow divider (paragraph 4—90). |
| | g. Flow divided drip valves clogged, with fuel pressure over 5 psi, or obviously stuck open, with fuel pouring from overboard drain. | Cap discharge line from drip valves. If engine will now start, replace flow divider (paragraph 4—90). |
| | h. Double-check valve defective (except J47-11, -15 and -19). | Inspect visually and replace stopcock if necessary (paragraphs 4—77 and 4—78). |
| | i. Linkage to main fuel regulator disconnected, jammed, or misadjusted. | Inspect visually and readjust if necessary (paragraph 4—94). |
| | j. VCO line and regulator line to gear case crossed. | Install lines to correct ports. |
| | k. Main fuel regulator or fuel control valve malfunctioning, or main fuel regulator not primed (especially in cases when new, replacement, or overhauled regulator has been installed). | Check by inserting gage in VCO pressure line and attempting start. If VCO pressure is less than 23 psi, prime main fuel regulator or replace it if necessary (paragraphs 4—80 and 4—81). (On all except J47-11, -15, and -19 engines, determine if the main fuel regulator is defective or requires priming by attempting start on emergency fuel system. If engine starts, the main fuel regulator is defective or should be primed.) If VCO pressure is greater than 23 psi, replace control valve (paragraph 4—70). |
| | l. Main fuel pump defective. | Replace main fuel pump (paragraphs 4—83 and 4—84) if it is suspected after making the above checks. |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Engine unable to reach 100 percent rpm at full throttle position. | 1. Faulty tachometer-indicator. | Replace aircraft's tachometer-indicator and recheck engine rpm. |
| | 2. Fuel system malfunctioning. **Note** On engines which incorporate an emergency fuel system, alternately run the engine on both the main and emergency fuel systems. If the engine is unable to reach 100 percent rpm on either system, then the trouble must be in a component, fuel line, etc, which is common to both systems. | |
| | a. Speed remains between 85 and 100 percent rpm because maladjustment of high speed stop or binding in linkage. | Adjust high speed stop on No. 4 island (paragraph 4—94, step "h," or 4—95 step "d") and check for binding in linkage. |
| | b. Speed considerably lower than 100 percent rpm, coupled with inadequate fuel pressure, due to faulty supply to engine, flow divider, or stopcock. | Check items listed under cause "3" for "Combustion does not occur during an attempted start." |
| | c. If speed is over 60 percent rpm but not 100 percent rpm, there may be a leak in compressor discharge line to No. 4 island, or solenoid in the line (except J47-11, -15, and -19) may be stuck open. | Check and replace line if necessary. Solenoid may be jarred loose by operating the emergency fuel system switch. |
| | d. Regulator control linkage misadjusted. | Check and adjust (paragraph 4—94). |
| | e. Oil pouring from compressor front frame drain, indicating leak in VCO line. | Replace line. |
| | f. Main fuel regulator or fuel control valve defective. | Insert gage in VCO line and attempt to reach top speed. VCO pressure should be approximately one-third of the fuel pressure plus 15 psi, or VCO pressure $= 1/3$ (fuel pressure) $+ 15$ psi. If VCO pressure is high, replace fuel control valve (paragraph 4—70). If VCO pressure is low, replace main fuel regulator (paragraphs 4—80 and 4—81). |
| | 3. Defective emergency fuel system components (except (J47-11, -15, and -19), if engine speed is less than it should be according to the ambient temperature, when running on the emergency system alone (emergency fuel system switch at "TEST" or "CHECK"). (See figure 4—16.) | |
| | a. Emergency control linkage misadjusted or binding. | Check and adjust (paragraph 4—96). |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Engine unable to reach 100 percent rpm at full throttle position. (Cont) | b. Emergency fuel regulator defective. | Replace emergency regulator (paragraphs 4—87 and 4—88). |
| | c. Emergency fuel pump defective. | Replace emergency fuel pump (paragraphs 4—83 and 4—84). |
| | **Note** If engine speed drops to 60 or 70 percent rpm with the engine running on the emergency fuel system alone, complete failure of the emergency fuel system is indicated. (At 60 percent rpm, the engine is running on the main fuel system only.) | |
| | 4. Speed lower than 100 percent rpm, coupled with excessive fuel pressure. | |
| | a. Partially clogged fuel nozzles or manifolds. | Remove and clear or replace nozzles and manifolds (paragraph 4—92). |
| | b. Flow divider defective or clogged. | Replace flow divider (paragraph 4—90). |
| Engine speed exceeds 100 percent rpm at full throttle position. | 1. Tachometer-indicator faulty. | Replace aircraft's tachometer-indicator and recheck engine rpm. |
| | 2. Emergency fuel system overriding main fuel system (except J47-11, -15, and -19). | Check by turning the emergency fuel system switch "OFF." If engine rpm drops to normal, the emergency system is overriding the main system. If not, the main fuel system is causing the overspeeding. See "3" below. |
| | a. Air sensing line to emergency fuel regulator open. | Check line for leaks and replace if necessary. |
| | b. Emergency control linkage maladjusted. | Check and adjust (paragraph 4—96). |
| | c. Emergency fuel regulator defective. | Replace emergency fuel regulator (paragraphs 4—87 and 4—88). |
| | 3. Main fuel system high speed stop improperly set. | Reset high speed stop on No. 4 island (paragraph 4—94, step "h," or 4—95, step "d"). |
| | 4. Main fuel regulator defective. | Replace main fuel regulator (paragraphs 4—80 and 4—81). |
| Engine surges or hunts with fixed throttle setting. | 1. Aircraft's fuel system malfunctioning. On engines with emergency fuel systems, this may be given a rough check by operating the engine alternately on both systems. | Insert a gage in fuel line that enters at No. 3 island and check for noticeable surges in boost pump pressure. Check items "3a," "3b," and "3c" under "Combustion does not occur during an attempted start." |
| | 2. If surging occurs only when the emergency fuel system is operating (except J47-11, -15, -19), the emergency fuel regulator is defective. | Replace emergency fuel regulator (paragraphs 4—87 and 4—88). |
| | 3. Main fuel regulator or fuel control valve defective. | Replace main fuel regulator (paragraphs 4—80 and 4—81). If trouble still persists, replace fuel control valve (paragraph 4—70). Reinstall the original main fuel regulator and recheck. |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Engine surges or hunts with fixed throttle setting. (Cont) | 4. If gage inserted in small slot manifold shows fluctuation, flow divider is probably defective. | Replace flow divider (paragraph 4—90). |
| | 5. If trouble remains after "1" through "4" above have been checked, fuel nozzles are probably defective. | Replace all fuel nozzles (paragraph 4—92). |
| Exhaust gas temperature over maximum. | 1. Temperature gage defective. | Calibrate temperature gage or replace it. |
| | 2. Exhaust gas thermocouple defective. | Measure exhaust gas thermocouple resistance. Replace if necessary. |
| | 3. Compressor inlet obstructed. | Remove obstructions. |
| | 4. One or more clogged or defective fuel nozzles. A completely clogged nozzle will cause dark streaks on the exhaust cone, and a partially clogged nozzle or one with a defective spray pattern will cause light streaks. Both conditions can be detected by looking up the tail pipe from a safe distance (approximately 200 feet) during engine operation. | Replace defective nozzles (paragraph 4—92). |
| | 5. Jet nozzle area too small, especially on a new installation. | Increase jet nozzle area. Refer to paragraph 1—75. |
| | 6. Worn or damaged inner combustion chambers or transition liners. | Remove combustion chambers (paragraph 4—16) and inspect inner combustion chambers (paragraph 4—18) and transition liners (paragraph 4—20). Replace inner combustion chambers if necessary. If transition liners are worn or damaged beyond limits, return the engine to an approved AMC activity. |
| | 7. Shroud ring clearance excessive, or shroud ring rubbing on turbine wheel, especially if shroud ring has been replaced or reinstalled. | Check shroud ring clearance (paragraph 4—32). |
| Low exhaust gas temperature. | 1. Temperature gage defective. | Calibrate temperature gage or replace it. |
| | 2. Exhaust gas thermocouples defective. | Measure thermocouple resistance. Replace if necessary. |
| | 3. Jet nozzle area too large. | Decrease jet nozzle area. Refer to paragraph 1—75. |
| Fuel mixing with lubricating oil. | 1. Internal break in oil cooler. This may be checked by removing drain plug and looking for fuel. Turn on boost pump to give fuel flow. | Replace oil cooler (paragraph 4—53). |
| | 2. Ruptured diaphragm in fuel control valve. This may be detected by breaking VCO return line at the valve, turning on the boost pump, and watching for fuel discharge from VCO port. | Replace fuel control valve (paragraph 4—70). |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Fuel mixing with lubricating oil. (Cont) | 3. Excessive fuel from fuel pumps getting into gear cases, possibly because of back pressure in drain systems. Check by breaking fuel drain lines at No. 3 island and measuring leakage with engine running. Lines reversed on flow divider would show an abnormal flow from overboard drain. | Remove restrictions from drain system. Check for correct connection of lines to flow divider. |
| Low or no lubricating oil pressure. | 1. Empty lube oil tank. | Check and fill. |
| | 2. Defective lube oil pressure gage. | Calibrate gage or replace it if necessary. |
| | 3. If lube oil tank empties rapidly and oil pours from turbine frame vents, the aft scavenge pump or lines are defective. | Replace aft scavenge pump (paragraph 4—55) or lines. |
| | 4. Broken oil lines. | Check for damaged lines and replace as required. |
| | 5. Clogged oil lines before pressure tap. | Check and replace as required. |
| | 6. Clogged main lube filter or regulator oil filter and orifice. | Remove and clean or replace (paragraphs 4—58 through 4—67). |
| | 7. Relief valve for bearing supply element in main lube pump malfunctioning. | Replace main lube pump (paragraph 4—51). |
| | 8. If the tachometer-indicator registers zero, the trouble may be an inoperative main lube pump. (The tachometer-generator is splined to the main lube pump shaft.) | Check main lube pump and replace if necessary (paragraph 4—51). |
| | 9. Missing "O" ring in oil line from compressor rear frame to No. 2, 3, and 4 bearing oil jets. | Return engine to an approved AMC activity if this trouble is indicated by shop air test described below. |
| High lubricating oil pressure. | Generally due to restrictions, pieces of rubber, crimped jets, or excess weld metal aft of the engine pressure tap. | Check by attaching shop air-line containing pressure gage just aft of main lube filter. Pressure at the engine pressure tap should be approximately one-third of any given shop air pressure. If pressure is low, see item "9" above. If pressure is high, check items "1," "2," and "3" below. |
| | 1. Clogged lines aft of pressure tap. | Repair or replace. |
| | 2. Restricted lube oil jets. | Return engine to an approved AMC activity. |
| | 3. Defective check valve aft of pressure tap. | Repair or replace. |
| Fluctuating lubricating oil pressure. | 1. Partially clogged line between lube oil tank and main lube pump. | Remove and clear or replace. |
| | 2. Oil pressure gage malfuctioning. | Check and replace if irregular. |
| | 3. Faulty main lube filter. | Clean or replace main lube filter (paragraphs 4—64 through 4—67). |

TABLE XI (Cont)

| Trouble | Probable Cause | Correction |
|---|---|---|
| Unusual noise and excessive vibration detected while engine is operating between approximately 70 and 80 percent rpm: | | |
| Hydraulic pressure line from No. 3 island vibrating excessively | Faulty hydraulic pump. | Replace pump. If vibration persists, return engine to approved AMC activity for engine bearing check. |
| Unusual noises detected during coasting after shutdown. | 1. Light clicking in vicinity of No. 3 or 4 bearings caused by normal shifting of bearing rollers and retainers or by turbine buckets looseness. | These conditions are acceptable. |
| | 2. Scraping sounds caused by turbine buckets rubbing on shroud ring. | Check shroud ring clearance (paragraph 4–32). |
| | 3. Harsh clicking or rattling, thumping, or bearing noise from any dry or misaligned bearings. | Return engine to an approved AMC activity. |
| | 4. Fuel pumps squeal as engine stops. | This condition is acceptable. |
| Starter-generator output incorrect | Starter-generator leads reversed. | Check leads and reconnect if necessary. |

## 4–8. MAINTENANCE OF BASIC ENGINE COMPONENTS.

4–8A. INLET GUIDE VANES.

4–8B. Look through the air inlet duct section and inspect the inlet guide vanes for cracks. Return the engine to an approved AMC activity if cracks are found in any area of the inlet guide vanes.

4–9. COMPRESSOR BLADES.

4–10. GENERAL. Inspect accessible compressor rotor and stator blades as described in paragraphs 4–11 and 4–12 at all regular inspection times. Table XII lists the definitions of the terms used in describing compressor blade damage.

**Note**

Accessible compressor rotor and stator blades are all blades that can be seen while looking through the air inlet duct section from the front of the engine. To aid in observing the rotor blades, the rotor may be turned by reaching through the exhaust cone and pushing against the turbine buckets with a long wooden pole.

4–11. ALLOWABLE DAMAGE AND MAINTENANCE OF COMPRESSOR BLADES.

a. Superficial damage such as minute dents, pits, mars, scratches, etc, which do not exceed the limits given in paragraph 4–12, are allowable in any number and at any location except that no dents or nicks are allowed in the root ½ inch of the blade.

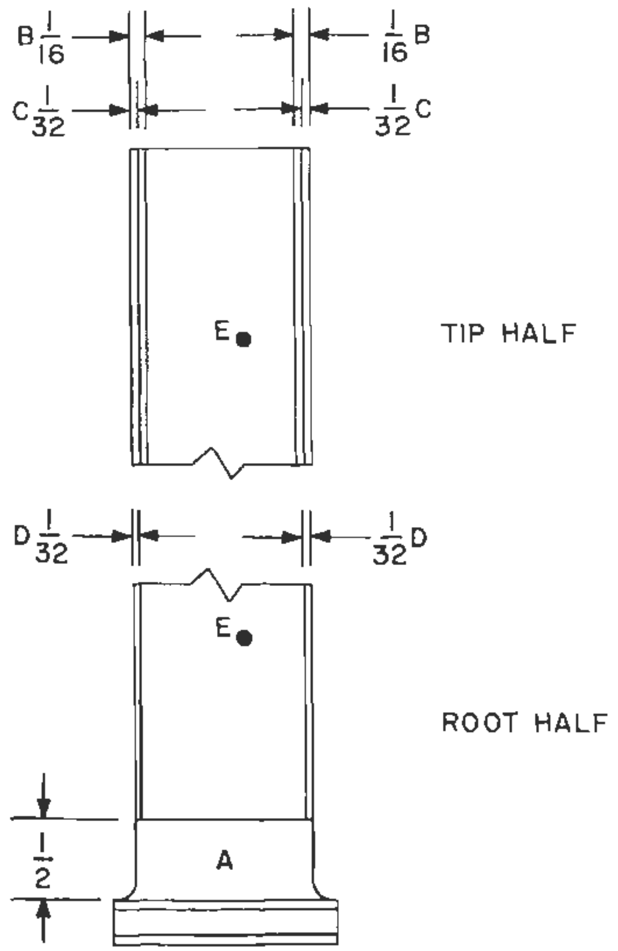



*Figure 4–1. Compressor Blade Inspection Limits*

b. Remove raised metal around allowable defects with a very fine emery cloth or by stoning in the direction of blade length.

4—12. DAMAGE NOT ALLOWABLE IN COMPRESSOR BLADES. Return the engine to an approved AMC activity if any compressor blades are damaged as noted below. Limits apply to both rotor and stator blades except as specified.

a. Cracks are not allowable.

b. Nicks and dents in the root ½ inch (A, figure 4—1) are not allowable.

c. Dents in the tip half leading or trailing edges exceeding 1/16-inch in depth (B) are not allowable.

d. Nicks in the tip half leading or trailing edges exceeding 1/32-inch in depth (C) are not allowable.

e. Nicks and dents in the root half leading or trailing edges exceeding 1/32-inch in depth (D) are not allowable.

f. Nicks and dents in the airfoil surface exceeding 1/32-inch in depth (E) are not allowable.

g. Blades may not have more than 2 nicks and/or dents in either the leading or trailing edges.

h. Rotor blades may not have more than a total of 3 nicks and/or dents. Stator blades may not have more than a total of 2 nicks and/or dents.

4—13. COMPRESSOR REAR FRAME.

4—14. INSPECTION OF COMPRESSOR REAR FRAME CABIN TAKE-OFF PORTS. Remove the fuel nozzles (paragraph 4—92) and visually inspect for cracks around the cabin take-off ports in the compressor rear frame by looking through the apertures from which the nozzles were removed. Return the engine to an approved AMC activity if the limits given in steps "a" through "d" below are exceeded. Refer to figure 4—1A.

a. Cracks which extend forward from the cabin take-off ports should not extend farther than 9-1/4 inches (dimension "Z") from the combustion chamber flange (compressor rear frame rear flange), or alternatively, more than 3 inches (dimension "X") from the front inner flange.

**TABLE XII**

**DEFINITIONS OF COMPRESSOR BLADE INSPECTION TERMS**

| Term | Definition |
|---|---|
| CORROSION | Any visible change in the blade surface finish due to chemical action. |
| CRACK | A parting of metal not accompanied by deformation. Cracks are usually found on the leading or trailing edges. |
| DENT | A smooth impression on a blade surface, such as the imprint made by a steel ball. A dent is generally shallow, with smooth edges and a rounded bottom. |
| MAR | A mar is any irregularity in the metal which is not readily visible but which can be felt by running a fingernail over the surface. |
| NICK | A gouge deeper than 0.010 inch, such as the imprint made by a pointed or irregular object. Nicks have steep sides and a "V" impression on the bottom. |
| PIT | A minute depression in the blade surface. Pits may occur during the manufacturing process, and may also be caused by erosion. |
| SCRATCH | An irregularity or furrow in the blade surface which is generally longer than it is wide and is usually quite shallow. |

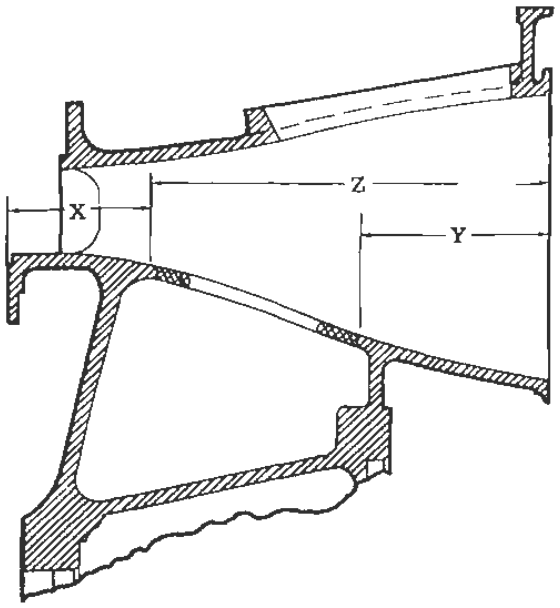



*Figure 4–1A. Inspection Limits for Compressor Rear Frame Cabin Take-off Ports*

b. Cracks which extend aft toward the combustion chamber flange may not approach the flange closer than 4-3/4 inches (dimension "Y").

c. A maximum of one crack per cabin take-off port is allowable.

d. A total of 4 cracks is the maximum allowable number in the compressor rear frame.

4–15. COMBUSTION CHAMBERS.

4–16. REMOVAL AND REPLACEMENT OF COMBUSTION CHAMBERS.

a. Disconnect all accessible fuel drain tubing from the combustion chambers.

b. Disconnect the igniter plug leads and remove the igniter plugs (paragraph 4–48). Place the igniter plugs in a suitable box to prevent damage to the porcelain.

c. Remove the cross-ignition bellows guards and the outer and inner cross-ignition tube assemblies.

d. Remove the Marman clamps from the front and rear ends of the combustion chambers.

e. Remove the bolt and washer from the aft end of each chamber. This bolt locks the inner chamber in place and secures it to the outer chamber.

f. Insert a finger through the cross-ignition tube opening and slide the inner combustion chamber forward about 3/8 inch.

g. Remove the combustion chamber assemblies in the following order: No. 4, 3, 2, 1, 5, 6, 7, and 8. This order will simplify the disconnection of the fuel drain lines. Disconnect and remove all attached tubing as each combustion chamber assembly is removed. Do not remove the inner from the outer chambers unless inspection (paragraph 4–18) shows that the inner chambers require replacement.

**Note**

It may not be possible to disengage a combustion chamber assembly because the inner combustion chamber is still engaged with the transition liner. If this is the case, it may be necessary to use the combustion chamber bellows compressing clamp, Tool No. 1C988, in order to remove the combustion chamber assembly.

h. Install the combustion chambers in the reverse of the removal procedure. If necessary, use the combustion chambers bellows expanding clamp, Tool No. 1C989.

4–17. INSPECTION OF OUTER COMBUSTION CHAMBERS.

a. Inspect the outer combustion chambers for holes and distortion. These conditions are not allowable.

b. Inspect the outer combustion chambers for cracks, particularly around the drain fittings, and where applicable, around the water-injection manifolds. No cracks are allowable in any area.

**Note**

Capped-off water-injection manifolds will be found on some J47-7, -9, -11, -13, -15, and -19 engine outer combustion chambers even though none of these engines have water-injection systems.

c. Inspect the flanges. All flanges should be straight and flat. Distortion is not allowable in the forward and rear flanges.

d. Inspect the forward dome section ("A," figure 4–2) for nicks and dents. Dents that do not exceed 1/8 inch from the original contour of the chamber are allowable, provided that the diameter of any such dent is a minimum of 8 times its depth.

e. Inspect the barrel section of each chamber ("B"). Dents which do not exceed 1/4 inch from the original contour are allowable, provided the diameter of each dent is a minimum of 8 times its depth, with the following exceptions:

(1) Any dent which overlaps a seam weld must have a minimum diameter of 12 times its depth in order to be allowable. The maximum depth of such dents is 1/4 inch.

(2) Dents are not allowable in or within one inch of the cross-ignition duct flanges or bosses or the igniter plug flanges or bosses.

(3) On chambers with water-injection manifolds, dents in the water-injection manifold may not exceed 1/32 inch in depth. Dents that are in or include any portion of the water-injection manifold flange may not exceed 1/16 inch in depth and must have a minimum diameter of one inch in order to be allowable.

f. Inspect the bellows section ("C"). Small dents that do not restrict free movement of the bellows are allowable. When dents exist in this area, the chambers should be checked for free movement at the bellows.

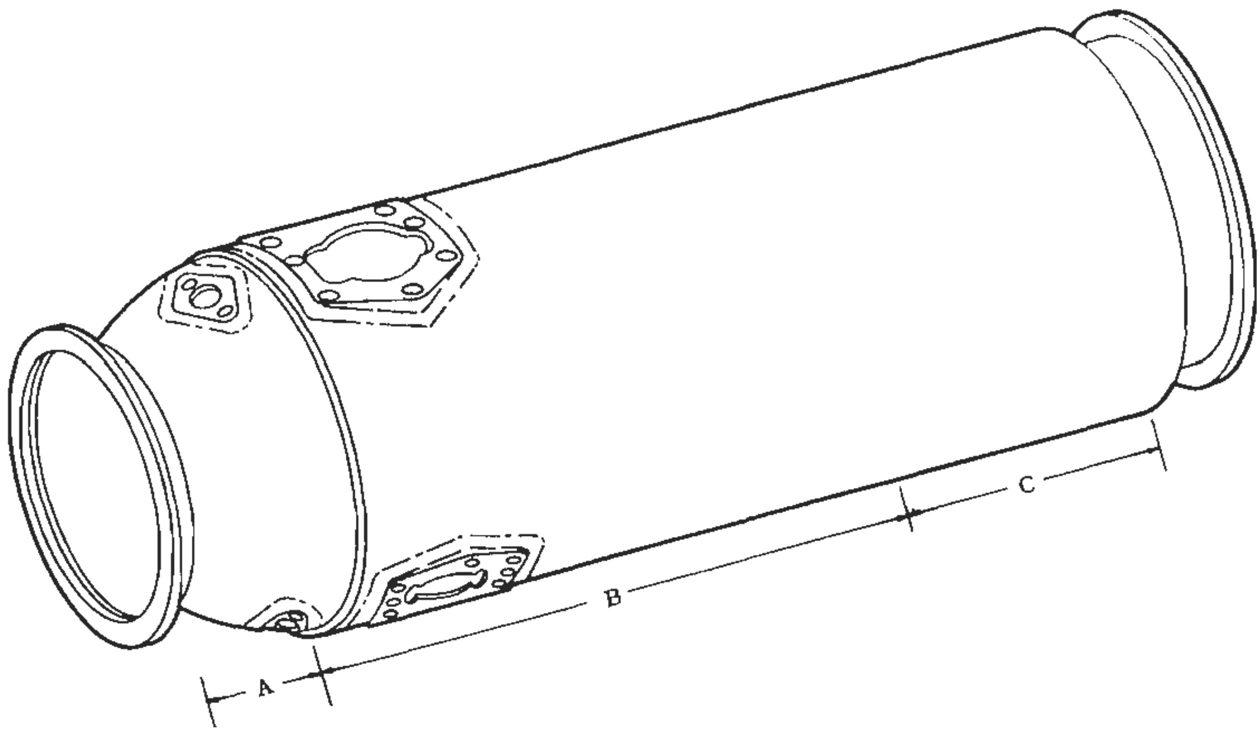



*Figure 4—2. Inspection Limits for Outer Combustion Chambers*

## 4—18. INSPECTION OF INNER COMBUSTION CHAMBERS.

**Note**

Do not remove the inner from the outer combustion chambers for purposes of inspection. Remove an inner chamber only if inspection reveals that it requires replacement.

a. Replace any inner combustion chamber which has holes burned through it, from which a piece has broken out, or which is so damaged that a piece is liable to break out.

b. Inspect each inner combustion chamber for proper contour. In the louvered area, buckling in excess of 1/2 inch above or below the original contour is not allowable. Buckling of less than 1/2 inch is allowable only if

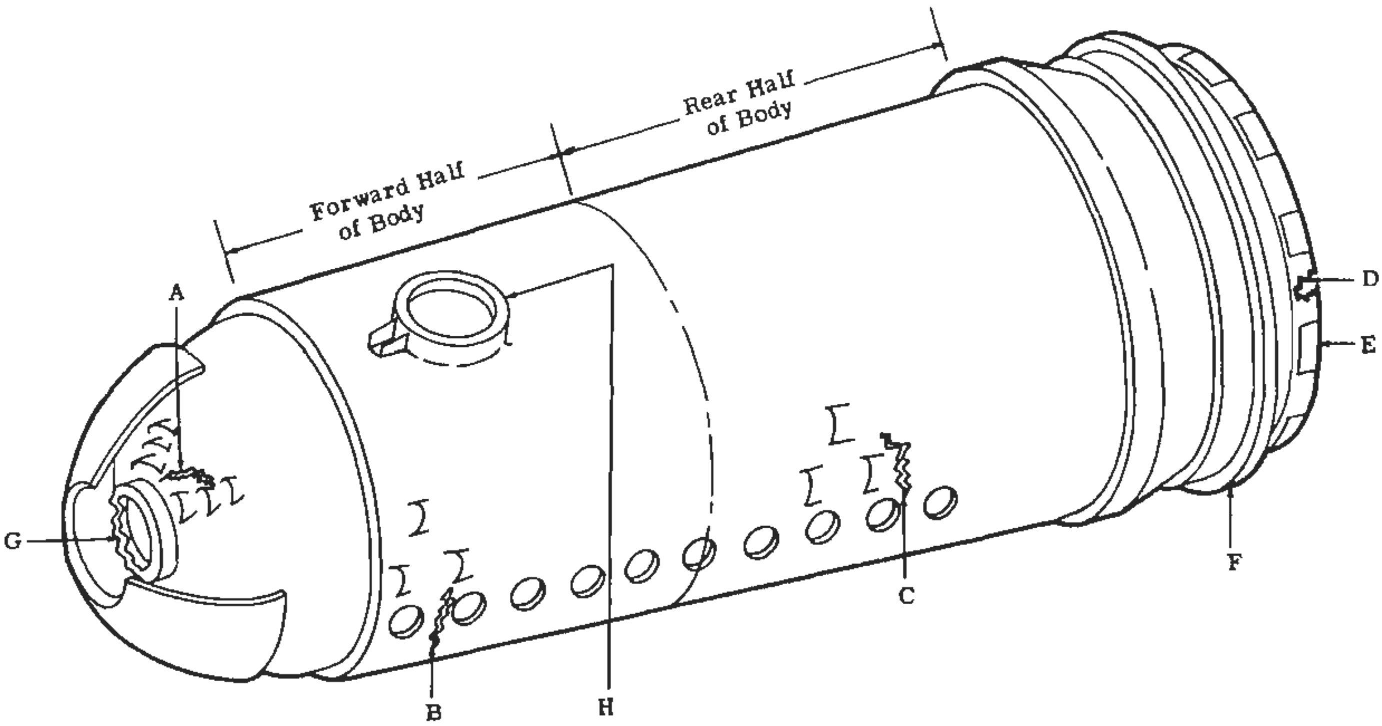



*Figure 4—3. Inspection Limits for Inner Combustion Chambers*

there are no major cracks present in the buckled area. Dishing or flattening of the contour over a large area is not allowable. Severe blisters and wrinkles are not allowable. No buckling which will permit the combustion gases to be directed through the side of the inner combustion chamber is allowable.

c. Inspect the wear lugs ("E," figure 4–3) to see that none are missing and that all spot welds are in good condition. Replace inner combustion chambers on which any wear lugs are worn to less than 0.020 inch thick.

d. Inspect the seal or support rings ("F"). All sections must be held securely to the inner combustion chamber.

e. Inspect the nozzle opening ("G") in the dome. The metal may be worn down to a minimum of 0.015 inch thick. The edge may be worn or broken for a maximum of 25 percent of its circumference.

f. Inspect the cross-ignition eyelet ("H"). The metal at the lip of the eyelet may be worn to 50 percent of its original thickness. Check the guides used on some combustion chambers to make sure that none are missing and that all spot welds are in good condition.

g. Inspect the inner combustion chambers for cracks. Table XIII lists maximum dimensions and number of allowable cracks in the different areas of the inner combustion chamber. Refer to figure 4–3. Chambers which have defects exceeding the limits given in the table must be replaced.

h. Replace any inner combustion chamber in which the strength of the material or its original characteristics have been destroyed or reduced by wear, burning, or erosion, or in which the material has been reduced to less than 50 percent of its original thickness.

4–19. TRANSITION LINERS.

4–20. INSPECTION OF TRANSITION LINERS. Inspect all transition liners for cracks, missing sections, loose or cracked retaining strips, and loose or missing locating buttons. Transition liners with pieces broken out of the main body or with cracks over 3 inches long in the main body area are not allowable. The limits for cracks and defects in critical areas are given in the following steps. Return the liners to an approved AMC activity if these limits are exceeded.

a. Cracks in the shaded area ("A") are not allowable.

b. Cracks ("B") emanating from the spot welds on the aft retainer are not allowable.

c. Cracks ("C") are not allowable in the flat side area.

d. In other areas, cracks ("D") up to 1/2 inch long are allowable provided there are not more than 4 per transition liner and none is closer than one inch to another.

e. Outer wear lugs ("E") may be worn to 0.060 inch, approximately half of their original thickness. Inner wear lugs may be worn to half their original thickness.

f. Cracks ("F") adjacent to the seam weld on the side of the transition liner are not allowable.

g. Cracked or loose brackets (retainers) and missing, cracked, or loose bracket pins ("G") are not allowable.

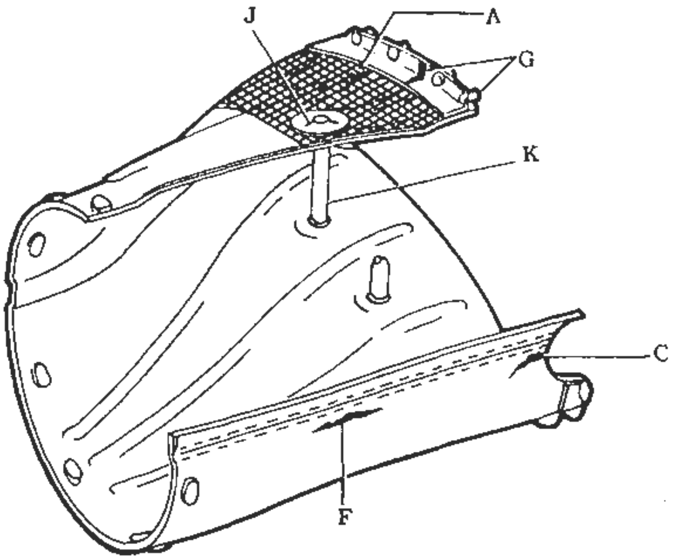
**Note**

Steps "a" through "g" apply to all transition liners; steps "h" through "j" below apply only to the post-type transition liners which are shown in figure 4–4. Disregard the following steps if post-type liners are not used.

**TABLE XIII**

**CRACK LIMITS FOR INNER COMBUSTION CHAMBERS**

| Location | Figure 4–3 Index | Allowable Cracks: Maximum Number | Allowable Cracks: Length (inches) | Remarks |
|---|---|---|---|---|
| Dome area | A | 8 | 3/8 (max) | Heat checks are allowable in any quantity unless open cracks are formed. The limits apply if cracks are formed. |
| Forward half of body to sixth row of holes | B | Any number<br>6 | 3/8 (max)<br>3/8 to 1-1/2 | Cracks longer than one inch are not allowable closer than one inch to another. |
| Rear half of body from sixth row of holes | C | Any number<br>10 | 1/2 (max)<br>1/2 to 2 | Cracks longer than one inch are not allowable closer than one inch to another. |
| Rear (unlouvered) area | D | 4 | ./2 (max) | Cracks closer than one inch to another are not allowable. |
| Cross-ignition tube eyelet | H | Any number | 1/4 (max) | These cracks will probably start at the eyelet lip. |



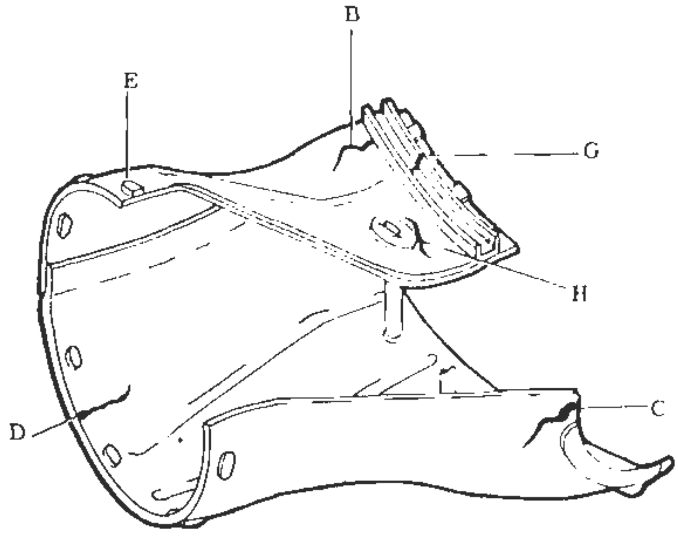




*Figure 4–4. Inspection Limits for Transition Liners*

h. Cracks ("H") are not allowable in or around the upper and lower stiffeners.

i. Cracks ("J") are not allowable in the fillet weld between the upper or lower stiffener and the post.

j. The post ("K") may be bent out of its normal position up to a maximum of 3/16 inch. Any bending or buckling of the post in excess of this limit is not allowable.

4–21. TURBINE NOZZLE DIAPHRAGM.

4–22. INSPECTION OF TURBINE NOZZLE PARTITIONS. Inspect all turbine nozzle partitions for the defects listed below. Refer to figure 4–5. If the partitions are damaged in excess of the limits given in the following steps, the engine must be returned to an approved AMC activity.

a. Inspect for weakened metal surfaces and for burning away of portions of the blades. These conditions are not allowable.

b. Circumferential cracks ("A" and "B") and radial cracks ("C" and "D") up to one inch in length are allowable, including those which terminate at the leading or trailing edge or at the inner or outer spacer band. A maximum of 3 cracks per partition is allowable, provided the cracks do not approach each other closer than 3/4 inch, including converging cracks ("E"). Combined radial and circumferential cracks ("F" and "G") are allowable, provided the circumferential crack does not exceed one inch in length and the radial crack does not exceed 1/2 inch in length. No other cracks are allowable in partitions which have one combined radial and circumferential crack.

**Note**

If all the partitions are damaged by excessive heat checking (inter-granular cracking), the engine must be returned to an approved AMC activity, even though no cracks may be visible in the partitions.

c. Buckling ("H") of the trailing edge of a partition is allowable if the displacement does not exceed 3/8 inch and not more than 8 partitions are damaged to the maximum limit. A total of 24 damaged partitions is allowable if the maximum displacement does not exceed 1/8 inch.

d. Dents are allowable in the partitions provided they do not exceed 1/16 inch in depth.

e. Ballooning or increase in the thickness of the partition contour ("M") if the maximum change does not exceed 1/4 inch and not more than one partition per section of 8 adjacent partitions is damaged to this maximum limit. A total of 24 damaged partitions is allowable if the maximum increase in partition contour does not exceed 1/16 inch.

4–23. INSPECTION OF TURBINE NOZZLE INNER AND OUTER SPACER BANDS. Inspect the inner and outer spacer bands for the defects listed below. The engine must be returned to an approved AMC activity if the limits given in the following steps are exceeded. Refer to figure 4–5.

a. Heat check (inter-granular) cracks ("K") are allowable on the inner spacer band in any quantity. If they combine to form one continuous open crack ("L"), only one such crack is allowable per section of 8 adjacent partitions.

b. Cracks ("N") in the edge of the inner spacer band are allowable provided they do not extend beyond a line joining the trailing edges of the partition slots. Cracks ("P") which extend from the corner of one slot at the trailing edge to an adjacent partition slot are allowable provided there is not more than one such crack per section of 8 partitions.

c. A crack ("Q") is allowable in the weld between a partition and the spacer band, provided its length does not exceed 50 percent of the weld length around the partition contour.

d. Nicks and dents are allowable in the inner spacer band, provided they do not exceed 1/16 inch in displace-

ment and have not started more than one crack per section of 8 partitions. Nicks and dents are allowable in the outer spacer band provided they have not started cracks more than 3/32 inch in length.

4–24. TURBINE ROTOR.

4–25. INSPECTION OF TURBINE WHEEL. With the exhaust cone removed (paragraph 4–29), inspect the rear face of the turbine wheel for scoring in areas where the hub cooling air deflector and the outer deflector on the exhaust cone may have rubbed. Return the engine to an approved AMC activity if the turbine wheel is scored.

4–26. INSPECTION OF TURBINE BUCKETS. Inspect the turbine wheel for missing buckets. Inspect buckets for the defects listed in the following steps. Return the engine to an approved AMC activity if the limits given below are exceeded.

a. Cracks are defined as any distinct breaks in the surface or the leading or trailing edge of a bucket. No cracks are allowable.

b. Dents are defined as smooth-edged impressions on the surface or leading or trailing edge of a bucket, and sudden changes in the contour or the bucket tip leading or trailing edges. Dents ("E," figure 4–6) in either the leading or trailing edge may not exceed a displacement of 1/16 inch in the upper half of area "B" or 1/32 inch in the lower half of area "B." No more than 4 dents are allowable per bucket.

**CAUTION**

No attempts shall be made to straighten a dent, since this may aggravate the injury.

c. Nicks are sharp-edged gouges or furrows with "V" shaped bottoms. Nicks are not allowable.

d. Inspect the leading and trailing edges of all buckets for compound or "S" curvature. (See figure 4–7.) If more than 25 percent of the buckets exhibit compound curvature, return the engine to an approved AMC activity, since this indicates that the turbine wheel has probably been subjected to overtemperature or other adverse operating conditions.

e. Check all buckets for circumferential tip movement (tip shake). Tip shake shall not exceed 0.125 inch. Check for axial movement of each bucket dovetail base in its turbine wheel slot by moving the bucket forward and aft by hand. The maximum allowable axial movement is 0.010 inch.

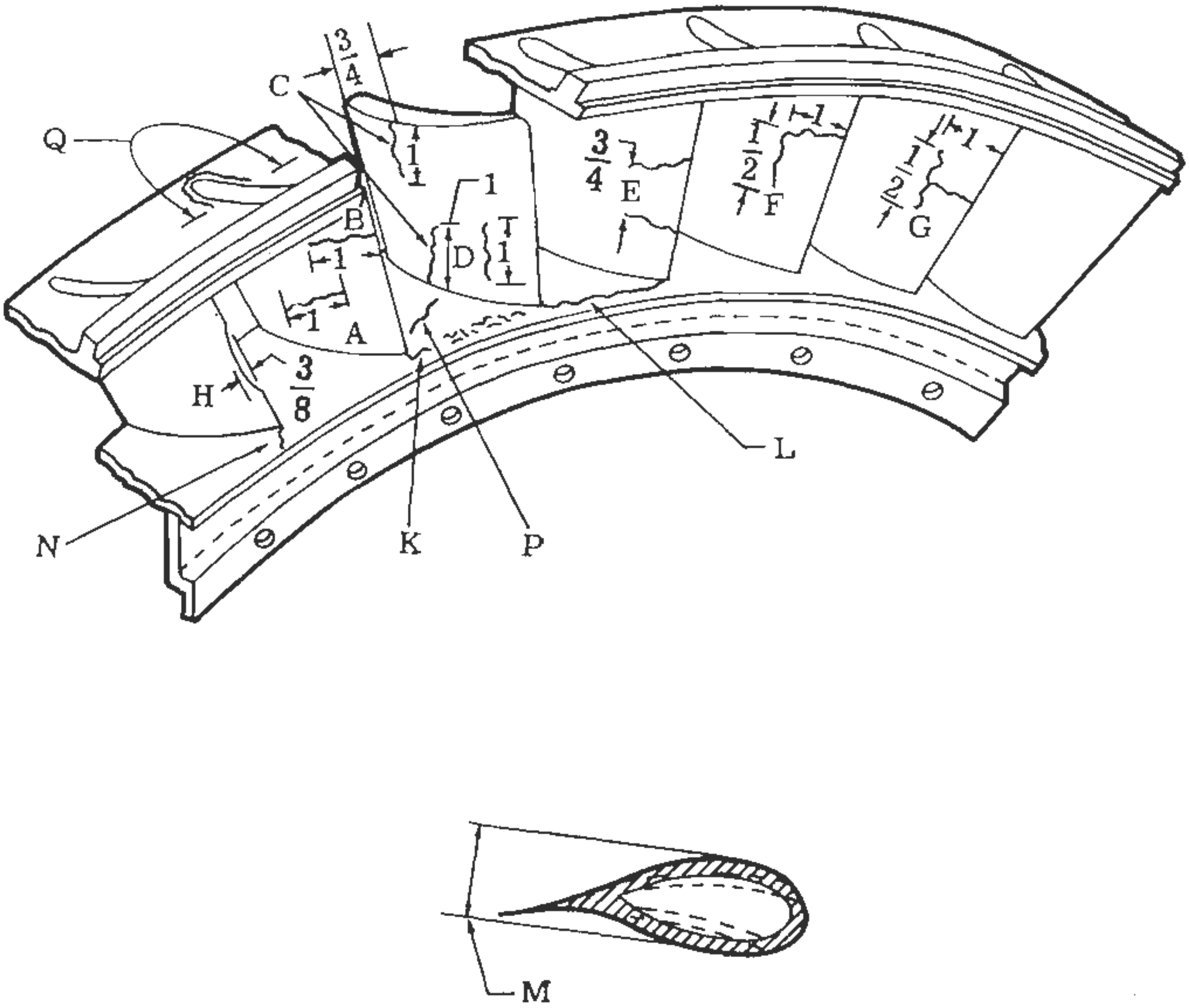



*Figure 4–5. Inspection Limits for Turbine Nozzle Diaphragm*

**Note**

The buckets are pinned from the forward side of the wheel in early model engines. For this kind of turbine wheel construction, the maximum allowable axial movement is 0.025 inch.

4-27. REPAIR OF TURBINE BUCKETS. It is permissible to repair minor injuries to the turbine buckets if the injuries are located in a repairable area and the benching required to remove them will not exceed the allowable repair limits given in the following steps. Refer to figure 4-6.

**Note**

Do not repair more than 4 injuries in any one bucket.

a. Injuries may be benched out in area "A" if a depth of 0.010 inch and a diameter of 1/8 inch are not exceeded in the removal of material.

b. Injuries may be benched and blended out in area "B" if the removal of material does not extend beyond the limits of area "B" and if not more than 25 percent of the turbine buckets require such repair.

c. Injuries in area "C" may be benched and blended out if a depth of 0.020 inch and a diameter of 1/4 inch are not exceeded in the removal of material.

**Note**

Repairs on opposite sides of a bucket are not allowable if they coincide to reduce the cross section of the bucket by more than the maximum depth of one repair.

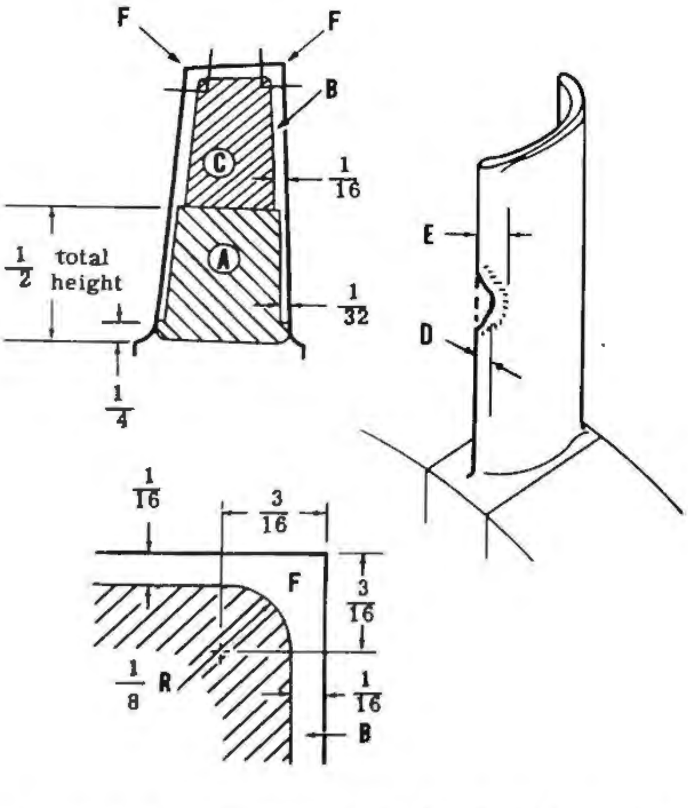



*Figure 4-6. Inspection Limits for Turbine Buckets*

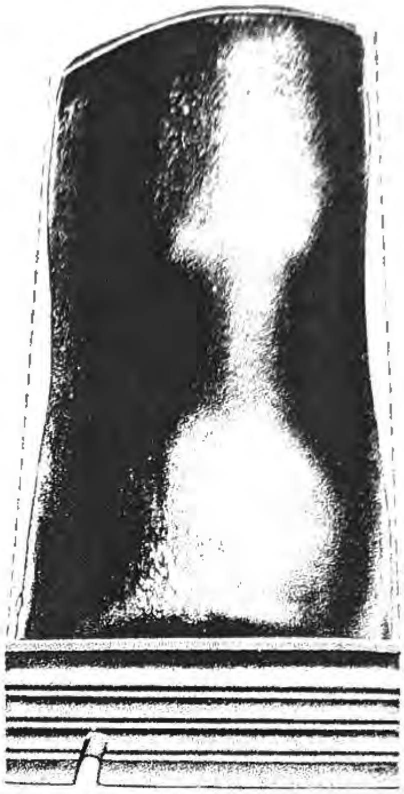


*Figure 4-7. Compound or "S" Curvature in Turbine Bucket*

d. The maximum allowable displacement of a bucket edge, as indicated at dimension "D," may not exceed 1/32 inch at the base half of the bucket length or 1/16 inch at the tip half.

e. Burring at the tip ends of the buckets, resulting from shroud ring rub, may be removed. Curling of bucket tip corners may be benched out if the rework does not extend beyond the limits of area "F."

**Note**

Repair of burring, curling, or burning may not be done if the damage has been caused by overtemperature operation. (Refer to paragraph 1-67.)

4-28. EXHAUST CONE.

4-29. REMOVAL OF EXHAUST CONE.

a. Disconnect the turbine wheel cooling air tube and the thermocouple lead clamps from the exhaust cone.

b. Remove the 80 nuts and bolts which secure the exhaust cone to the nozzle diaphragm ring on model J47-7 and -9 engines, or to the turbine casing on model J47-11, -13, -15, and -19 engines.

**CAUTION**

Leave a bolt in place at the top centerline until a strain has been taken on the exhaust cone.

c. Remove the exhaust cone from the engine.

**CAUTION**

Hold the exhaust cone flange shim (model J47-7 and -9 engines only) and the shroud ring in place while the exhaust cone is being removed. Damage may result if these parts are allowed to drop.

4—30. INSPECTION AND MAINTENANCE OF EXHAUST CONE.

a. Inspect the exhaust cone for cracks in the sheet metal and welds, for holes burned through it, and for areas where burning has weakened the metal. These conditions are not allowable and require that the exhaust cone be returned to an approved AMC activity.

b. Examine the exhaust cone outer skin for outward or inward buckling. In shaded area "X" shown on figure 4—8, maximum allowable buckling (dimension "A") is 1/4 inch, provided dimension "B" is a minimum of 6 times dimension "A." In shaded area "Y," maximum allowable buckling is 3/8 inch, with dimension "B" a minimum of 6 times dimension "A." The maximum allowable buckling in the unshaded area is 3/4 inch, provided dimension "B" is a minimum of 6 times dimension "A."

c. Inspect the front and rear mounting flanges for distortion. Distortion is allowable only if it will not necessitate excessive forcing to assemble the exhaust cone to the nozzle diaphragm ring or turbine casing at the forward end and to the tail pipe at the aft end. Excessive forcing may weaken or damage the parts and also create gaps which might allow exhaust gas leakage.

d. Inspect the mounting flanges for nicks and burrs and remove any irregularities with an Arkansas stone.

e. Inspect for axial shift of the inner cone. Axial shift is allowable as long as the specified clearances (Reference No. 3, 4, and 5, table XIV) will not be exceeded when the exhaust cone is assembled to the engine. (Refer to paragraph 4—31.)

f. Inspect for radial shift of the inner cone. Radial shift is allowable if the inner cone is essentially secure and if its outside diameter does not extend into the exhaust gas stream.

g. The support rod plates for the fairings in early model exhaust cones are secured with 4 round-head rivets instead of the 2 countersunk flat-head rivets used in later models. If close visual inspection reveals that any of the round-head rivets are sheared off or are about to fail, return the exhaust cone to an approved overhaul activity.

4—31. CLEARANCE CHECK BETWEEN EXHAUST CONE AND TURBINE ROTOR.

a. On model J47-7 and -9 engines, install the exhaust cone flange shim.

b. Place the exhaust cone to turbine wheel clearance gage, Tool No. 1C984, over the turbine rotor wheel

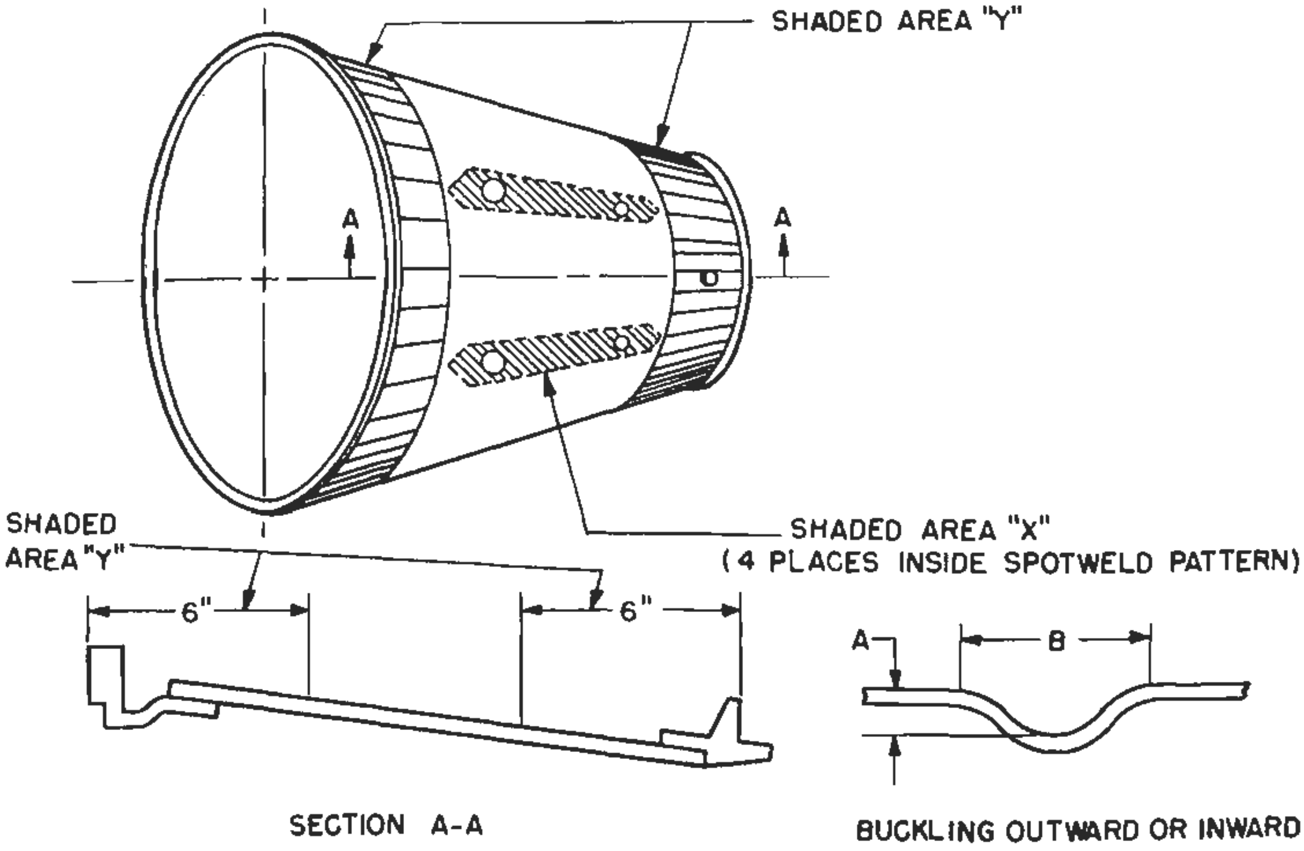



*Figure 4—8. Inspection Limits for Exhaust Cone*

hub and fasten it to the nozzle diaphragm ring or turbine casing with the 4 knurled finger screws. (See figure 4–9.) Make certain the gage is seated on the flange of the nozzle diaphragm ring or turbine casing all the way around.

c. Adjust all the knurled screws until they touch the turbine rotor and lock the screws in position.

d. Place the exhaust cone in a vertical position, aft end down. Remove the gage from the turbine wheel and place it on the front flange of the exhaust cone with the knurled heads of the screws next to the exhaust cone and the points facing up. The positions of the screw heads represent the contour of the turbine rotor near the exhaust cone air baffles.

e. Measure the clearances between the knurled screw heads and the edges of the inner exhaust cone and the air baffles. These represent the clearances between the exhaust cone and turbine rotor, and must be within the specified limits (Reference No. 3, 4, and 5, table XIV).

f. If any of the clearances obtained in step "e" above are excessive, the exhaust cone shall be returned to an approved AMC activity. If any clearances fall below the specified limits, however, the edges of the inner cone and air baffles may be ground down uniformly to obtain the proper clearance all around.

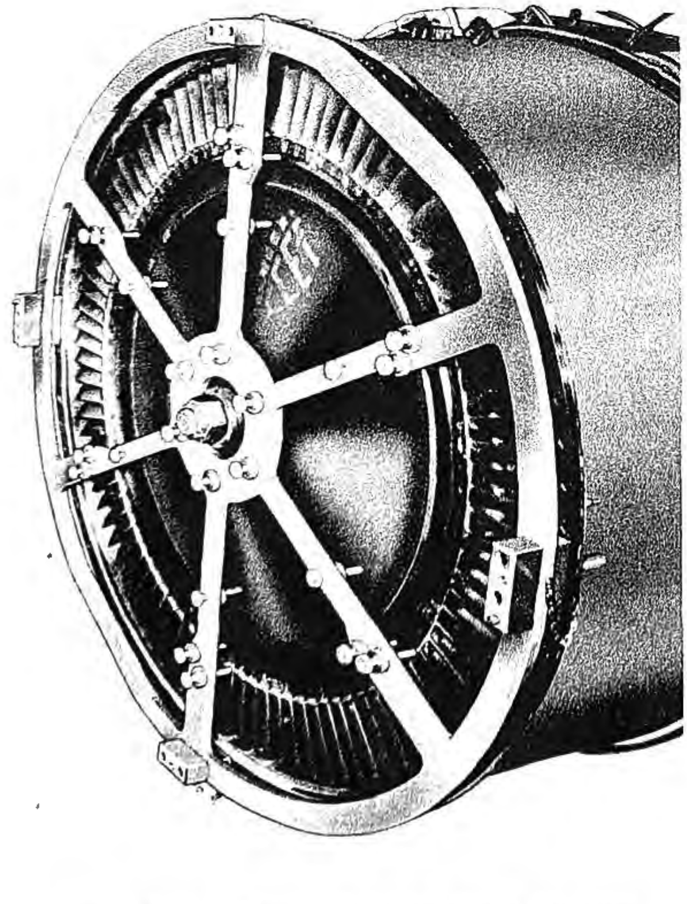


*Figure 4–9. Clearance Gage Installed over Turbine Wheel*

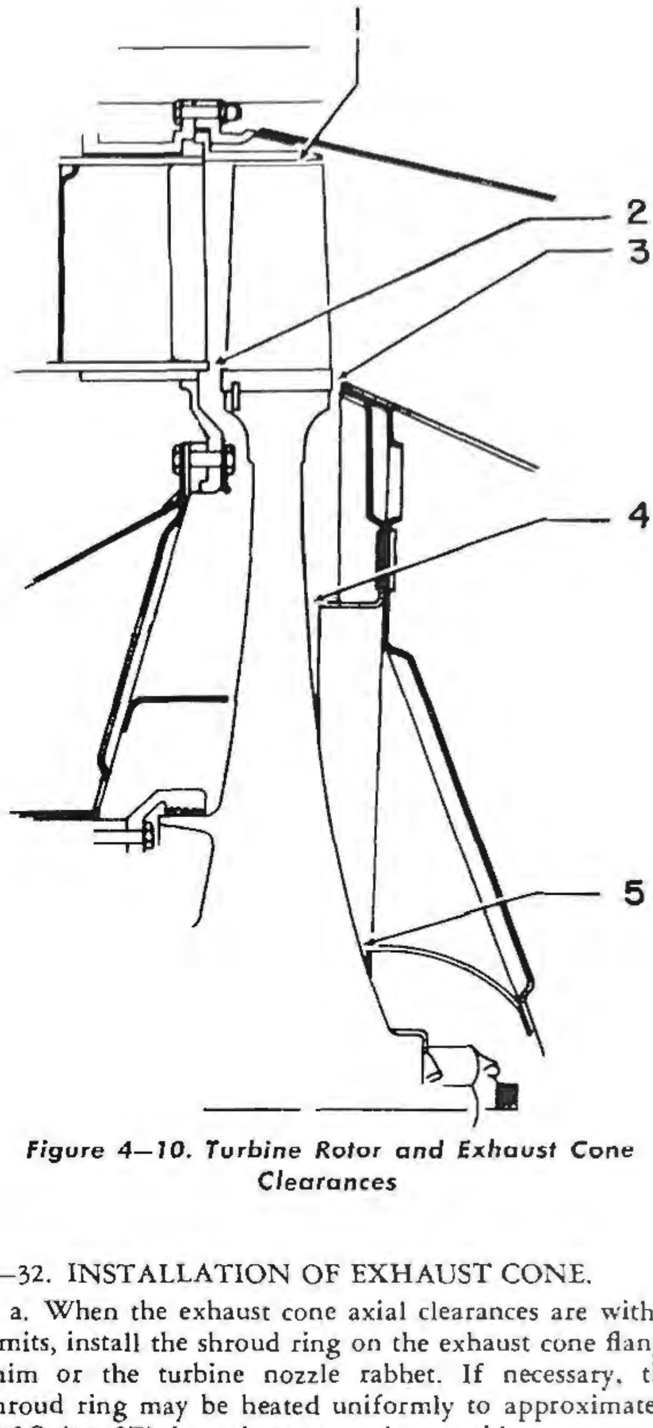



*Figure 4–10. Turbine Rotor and Exhaust Cone Clearances*

4–32. INSTALLATION OF EXHAUST CONE.

a. When the exhaust cone axial clearances are within limits, install the shroud ring on the exhaust cone flange shim or the turbine nozzle rabbet. If necessary, the shroud ring may be heated uniformly to approximately 82°C (180°F) in order to permit assembly.

b. Place 4 strips of 0.070- to 0.080-inch feeler gage stock or shim stock 10 inches long between the tips of 4 equally spaced turbine buckets and the shroud ring.

c. Install the exhaust cone over the shroud ring and fasten the mating flanges tightly together with 4 or 5 bolts and nuts placed opposite each piece of shim or feeler stock. Take the radial bucket tip clearance (Reference No. 1, table XIV) by reaching through the exhaust cone.

d. When the bucket tip clearance falls within the specified limits, install the remaining bolts and nuts and torque all nuts to the value given in table XVII.

e. Remove the feeler or shim stock and recheck the bucket tip clearance in at least 8 equally spaced positions.

TABLE XIV

TURBINE ROTOR AND EXHAUST CONE CLEARANCES

| Reference Figure 4—10 No. | Index No. | Description | Direction | Clearance (in.) Min | Max | Replace |
|---|---|---|---|---|---|---|
| 1 | 1 | Turbine bucket tips to shroud ring | Radial | | | |
| | | At every single point: | | | | |
| | | Installation of same or replacement shroud ring | | 0.045 | 0.140 | |
| | | After engine operation, with all parts at ambient temperature | | 0.030 | 0.140 | |
| | | Average of at least 4 equally spaced points | | 0.058 | —— | |
| 2 | 2 | Turbine rotor to turbine nozzle diaphragm inner spacer band edge | Axial | 0.400 | 0.614 | |
| 3 | 3 | Turbine rotor to inner exhaust cone outer edge | Axial | 0.130 | 0.408 | 0.125—0.500 |
| 4 | 4 | Turbine rotor to inner exhaust cone outer baffle | Axial | 0.307 | 0.644 | 0.300—0.844 |
| 5 | 5 | Turbine rotor to inner exhaust cone inner baffle | Axial | 0.344 | 1.258 | 0.340—1.455 |

f. Reconnect the thermocouple lead clamps and the turbine wheel cooling air tube to the exhaust cone.

4—33. POWER TAKE-OFF ASSEMBLY.

4—34. REMOVAL OF POWER TAKE-OFF ASSEMBLY.

a. Disconnect the clamp holding the fire extinguisher tube.

b. On model J47-7 and -13 engines, disconnect the breather line from the reducer on the hydraulic pump drive gear case assembly. On J47-13 engines with serial No. 046927 and above, disconnect the lube oil lines for the PTO scavenge pump.

c. Remove the 2 bolts and washers which secure the regulator oil filter and orifice and bracket to the web in the 2 o'clock position. Disconnect the lines and remove the regulator oil filter and orifice.

d. Cut the lockwire and remove the bolts and washers securing the fuel filter at the 3 o'clock position. Disconnect the lines and remove the fuel filter.

e. Cut the lockwire and remove the 2 bolts and washers securing the fuel control valve to the web in the 7 o'clock position. Disconnect the lines and remove the fuel control valve.

f. Use a short screwdriver to remove the bolts and nuts which secure the sections of the air inlet screen assembly. Remove the Marman clamp (on engines which incorporate the forward-sloping air inlet screens) and remove the screens.

g. On J47-7 and -13 engines, remove the 9 screws which secure the hydraulic pump drive gear case assembly to the power take-off assembly. Lift off the hydraulic pump drive gear case. If present, remove the PTO scavenge pump after removing 3 bolts and washers.

h. On J47-9 and -15 engines, remove the 9 screws which secure the alternator pad assembly and lift off the assembly from the power take-off assembly.

i. On J47-11 and -19 engines, remove the 6 screws and remove the accessory support mount from the power take-off assembly.

j. Remove the 4 island guide assemblies.

k. Remove 9 screws and remove the power take-off assembly from the accessory drive gear box.

4—35. REPLACEMENT OF POWER TAKE-OFF ASSEMBLY.

a. Secure the power take-off assembly to the blocks on the accessory drive gear box with 9 screws. Lockwire each screw to a rivet located on the outer surface of the power take-off assembly.

b. Install the 4 island guide assemblies.

c. On J47-13 engines with serial No. 046927 and above, install the PTO scavenge pump to the hydraulic pump drive gear case.

d. On J47-7 and -13 engines, install the hydraulic pump drive gear case to the power take-off assembly, engaging the pin in the shaft housing with the slot in the rear cap of the hydraulic pump drive gear case. It may be necessary to turn the pinion in order to engage the splines of the power take-off shaft. Secure the assembly with 9 screws.

e. On J47-9 and -15 engines, secure the alternator pad assembly to the power take-off assembly with 9 screws. Follow the procedure given in step "d" above.

f. On J47-11 and -19 engines, secure the accessory support mount to the power take-off assembly with 6 screws.

g. Install the sections of the air inlet screen assembly and secure them with bolts and nuts and the Marman clamp, if provided.

h. Install the fuel control valve, the fuel filter, and the regulator oil filter and orifice in the reverse order of removal and lockwire the bolts. Connect all fuel and lube oil hoses to their proper ports.

i. On J47-13 engines with serial No. 046927 and above, connect the lube oil lines for the PTO scavenge pump. On all J47-7 and -13 engines, connect the breather line to the reducer on the hydraulic pump drive gear case assembly.

j. Connect the clamp which secures the fire extinguisher tube.

**4—36. MAINTENANCE OF ELECTRICAL SYSTEM COMPONENTS.**

4—37. STARTER-GENERATOR OR STARTER.

4—38. REMOVAL AND REPLACEMENT OF STARTER-GENERATOR OR STARTER.

a. Remove the power take-off assembly (paragraph 4—34).

b. Tag each lead and its corresponding connection in order to insure identical reassembly. Disconnect all leads.

c. Before removing the mounting nuts, take the strain by using a lifting sling or by having a second man support the starter-generator or starter. Remove 6 self-locking nuts and 6 washers and remove the starter-generator or starter.

d. Before replacing the starter-generator or starter, install a new gasket on the mounting pad. Install the starter-generator or starter and secure it with 6 washers and self-locking nuts. Connect the leads and secure with twisted lockwire.

4—39. TACHOMETER-GENERATOR.

4—40. REMOVAL AND REPLACEMENT OF TACHOMETER-GENERATOR.

a. Remove the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions in paragraph 4—34.

b. Disconnect the electrical connection at the tachometer-generator.

c. Cut the lockwire, remove the 4 nuts and washers, and remove the tachometer-generator from the main lube pump.

**Note**

The tachometer-generator cable support clamp is secured by one of the tachometer-generator mounting nuts.

d. Replace the tachometer-generator in the reverse order of removal, using a new gasket.

4—41. IGNITION UNITS (MODEL J47-7, -9, -11, -13, AND -15 ENGINES).

4—42. REMOVAL AND REPLACEMENT OF IGNITION UNITS.

a. Disconnect the leads from the ignition units.

b. Remove 4 screws from each housing and remove the 2 housing assemblies.

c. To remove each ignition unit, remove 4 bolts and washers. Remove ignition unit, 4 insulating washers, the ignition unit shield, and 4 spacers from the compressor stator casing.

d. Replace the ignition units in the reverse order of removal.

4—43. TRANSFORMERS (MODEL J47-19 ENGINES).

4—44. REMOVAL AND REPLACEMENT OF TRANSFORMERS.

a. Disconnect the electrical leads from each transformer.

b. Remove screws and washers and remove the transformer shrouds.

c. To remove each transformer, remove 4 nuts, 2 transformer clamping plates, and 4 mounting spacers.

d. Replace the transformers in the reverse order of removal.

4—45. JUNCTION BOX.

4—46. REMOVAL AND REPLACEMENT OF JUNCTION BOX.

a. Disconnect the electrical cables from the junction box.

b. To remove the junction box from the compressor front frame, remove 4 internal-wrenching bolts and 4 washers.

c. Replace the junction box in the reverse order of removal.

4—47. IGNITER PLUGS.

4—48. REMOVAL AND REPLACEMENT OF IGNITER PLUGS.

a. To remove the igniter plugs, disconnect the leads and remove the 2 screws which secure each igniter plug to the outer combustion chamber. Remove the igniter plugs and gaskets.

**Note**

In all except the J47-19 engine, dual-electrode igniter plugs are used, and are located in the No. 2 and 7 combustion chambers. In J47-19 engines, 4 single-electrode igniter plugs are used, 2 each in the No. 3 and 7 combustion chambers.

b. Replace the igniter plugs in the reverse order of removal.

4—49. CLEANING AND INSPECTION OF IGNITER PLUGS.

a. Clean all oil and grease from the threads and exposed parts of the igniter plugs, using a soft bristle brush dipped in cleaning solvent, Federal Specification P-S-661. Dry with compressed air.

b. Install the plugs in a blast cleaning machine and blast clean according to the regular operating instructions for the machine. Remove the plugs and wash them thoroughly in the cleaning solvent. Dry with compressed air.

c. Inspect the porcelain to see if it is cracked or broken. Inspect the electrodes for pitting and erosion. Replace damaged or eroded igniter plugs.

d. Check for a spark gap of 0.090 to 0.110 inch on dual-electrode igniter plugs. If resetting is necessary, set the gap at 0.095 to 0.105 inch.

e. Check for an electrode length of 4-9/32 to 4-11/32 inches on single-electrode igniter plugs, measuring from the bottom surface of the mounting flange to the tip. Replace the igniter plugs if the electrode length does not fall within the specified limits.

**Note**

When the single-electrode igniter plugs are installed, the gap between the 2 electrodes in each combustion chamber should be 3/8 to 1/2 inch.

**4—50. MAINTENANCE OF LUBRICATION SYSTEM COMPONENTS.**

4—51. REMOVAL AND REPLACEMENT OF MAIN LUBE PUMP.

a. Remove the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions in paragraph 4—34.

b. Disconnect the electrical connection at the tachometer-generator. The tachometer-generator may be removed either before or after the main lube pump is removed from the accessory drive gear box. Refer to paragraph 4—40.

c. Disconnect the lube oil hoses from the main lube pump.

d. Note the method of lockwiring and then cut the lockwire from the bolts which secure the main lube pump to the accessory drive gear box. Remove the 4 bolts and washers and remove the main lube pump.

e. Install the tachometer-generator on the replacement main lube pump. The electrical connection must be directly forward of a point located between the inlet and outlet ports of the pump. The tachometer-generator mounting nut which is located in front of the lube pump outlet port should be left loose until the tachometer-generator cable support clamp is installed.

f. Install the main lube pump to the accessory drive gear box, using a new gasket if necessary. Secure the cable and its support clamp to the tachometer-generator.

g. Tighten the main lube pump mounting bolts and safety them in pairs with twisted lockwire.

4—52. OIL COOLER AND BYPASS AND RELIEF VALVE.

4—53. REMOVAL AND REPLACEMENT OF OIL COOLER AND BYPASS AND RELIEF VALVE.

a. Disconnect the lube and fuel lines at the oil cooler.

b. Remove 4 bolts and washers to remove the oil cooler from the lower half of the compressor stator casing.

c. The bypass and relief valve may be removed from the oil cooler by removing the bolts and nuts or bolts and washers which secure it.

d. Replacement is the reverse of removal. Use new packing or gaskets if the bypass and relief valve was removed from the oil cooler. Be sure to connect the fuel and lube oil lines to their correct ports.

4—54. AFT SCAVENGE PUMP.

4—55. REMOVAL AND REPLACEMENT OF AFT SCAVENGE PUMP.

a. To remove the aft scavenge pump, it is necessary to remove the No. 4 and 5 combustion chambers. (Refer to paragraph 4—16.)

b. Disconnect the scavenge oil tube and remove the 3 bolts and washers which secure the pump to the compressor rear frame. Remove the aft scavenge pump and its gasket.

c. Replace the scavenge pump in the reverse order of removal.

**Note**

Before final tightening of the mounting bolts, turn the compressor rotor by hand to insure proper mating of the pump drive gear.

4—56. POWER TAKE-OFF SCAVENGE PUMP (MODEL J47-13 ENGINES).

4—57. REMOVAL AND REPLACEMENT OF POWER TAKE-OFF SCAVENGE PUMP. Removal and replacement of the PTO scavenge pump is covered in paragraphs 4—34 and 4—35.

4–58. REGULATOR OIL FILTER AND ORIFICE (HYDRO-AIRE MODEL 3856).

4–59. REMOVAL AND REPLACEMENT OF REGULATOR OIL FILTER AND ORIFICE. Removal and replacement of the regulator oil filter and orifice is covered in paragraphs 4–34 and 4–35.

4–60. DISASSEMBLY OF REGULATOR OIL FILTER AND ORIFICE. (See figure 4–11.)

a. Remove the self-locking nut (2) and washer (3), and take the body assembly (14) and element assembly (9) from the bowl (1).

b. Remove the spring (7), washer (3), and "O" ring packing (4) from the bowl.

c. Remove the cotter pin (6) from the bolt (5), and remove the washer (3) and "O" ring packing (15) from the body assembly (14).

4–61. CLEANING REGULATOR OIL FILTER AND ORIFICE.

a. Immerse all parts except the element assembly in cleaning solvent, Federal Specification P-S-661. If necessary, use a brush to clean the parts thoroughly. Allow the parts to drain and dry them with a lint-free cloth.

b. Clean the element assembly with a soft hair brush dipped in the cleaning solvent.

c. Blow dry compressed air through the element assembly from the center forward.

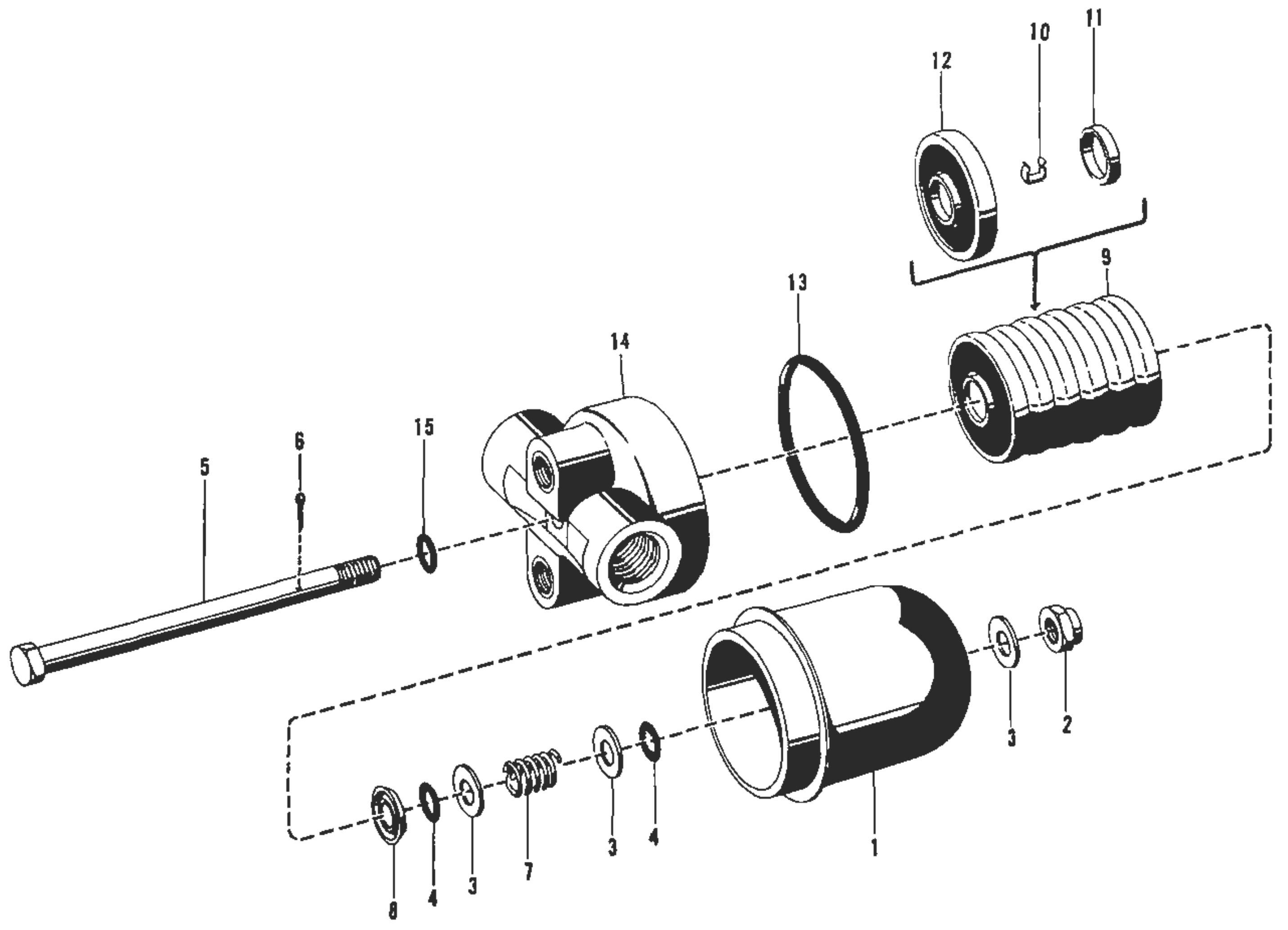
4–62. ASSEMBLY OF REGULATOR OIL FILTER AND ORIFICE. (See figure 4–11.)

a. Reassemble the element assembly to the body by assembling the bolt (5) and "O" ring packing (15) to the body assembly (14). Install the element assembly (9), seal (8), "O" ring packing (4), and washer (3) on the bolt (5). Secure with cotter pin (6).

b. If the "O" ring packing (13) has been removed, install it on the bowl (1).

c. Assemble the spring (7), washer (3), and "O" ring packing (4) to the bolt (5).

d. Assemble the bowl (1) to the entire assembly and secure with the self-locking nut (2) and washer (3). Torque the nut (Reference No. 27, table XVII).




1. Bowl
2. Self-locking Nut
3. Washer
4. "O" Ring Packing
5. Bolt
6. Cotter Pin
7. Spring
8. Seal
9. Element Assembly
10. Clip
11. Spacer
12. Disc Assembly
13. "O" Ring Packing
14. Body Assembly
15. "O" Ring Packing

*Figure 4–11. Regulator Oil Filter and Orifice, Hydro-Aire Model 3856*

4–62A. REGULATOR OIL FILTER AND ORIFICE (AIR-MAZE MODELS OS12223B, OS12223F, and OS12223G).

4–62B. REMOVAL AND REPLACEMENT OF REGULATOR OIL FILTER AND ORIFICE. Same as for Hydro-Aire Model 3856. Refer to paragraphs 4–34 and 4–35.

4–62C. DISASSEMBLY OF REGULATOR OIL FILTER AND ORIFICE. (See figure 4–11A.)

a. Cut the lockwire and unscrew the sump (1) from the body (9).

b. Remove the cotter pin (5), nut (6), retainer cup (2), filter packs (3), and washer (4).

c. Unscrew the strainer assembly (7) from the body (9).

d. Remove and discard the "O" ring (8).

4–62D. CLEANING OF REGULATOR OIL FILTER AND ORIFICE. Same as for Hydro-Aire Model 3856. Refer to paragraph 4–61.

4–62E. ASSEMBLY OF REGULATOR OIL FILTER AND ORIFICE. (See figure 4–11A.)

a. Install a new "O" ring (8) on the body (9).

b. Screw the strainer assembly (7) into the body and torque to 40-50 lb in.

c. Assemble the washer (4), filter packs (3), retainer cup (2), and nut (6) on the strainer assembly. Torque the nut to 10-15 lb in. and secure with the cotter pin (5).

d. Screw the sump (1) on to the body (9) and torque to 10-14 lb ft.

4–63. MAIN LUBE FILTER.

4–64. REMOVAL AND REPLACEMENT OF MAIN LUBE FILTER.

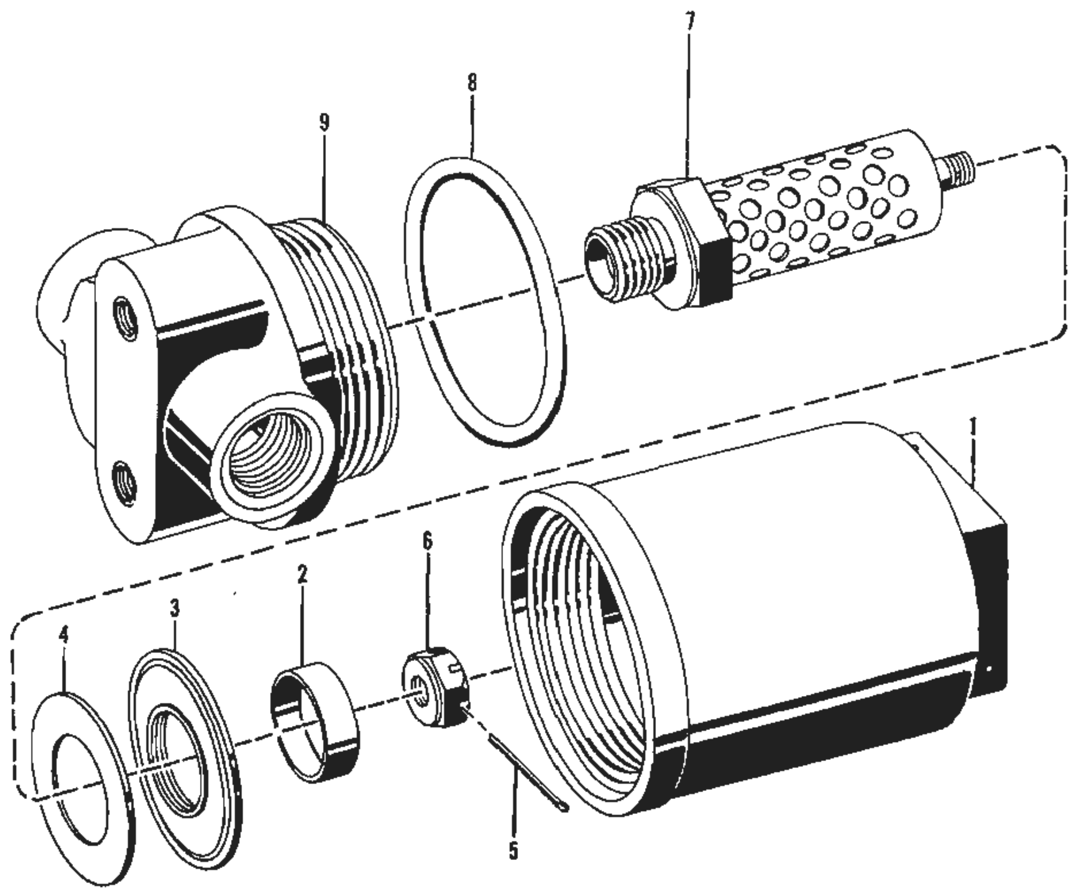
a. Disconnect the lube hose assemblies from the main lube filter.

b. Remove the 4 bolts and washers which secure the main lube filter to the lower half of the compressor stator casing and remove the filter.

c. Replacement of the main lube filter is accomplished in the reverse order of removal.

4–65. DISASSEMBLY OF MAIN LUBE FILTER. (See figure 4–12.)

a. Cut the lockwire that secures the sleeve nut (4) and remove the sleeve nut. Remove the packing (1) from the sleeve nut.




1. Sump
2. Retainer Cup
3. Filter Pack
4. Washer
5. Cotter Pin
6. Nut
7. Strainer
8. "O" Ring
9. Body

*Figure 4–11A. Regulator Oil Filter and Orifice, Air-Maze Model OS12223B, OS12223F, and OS12223G*

b. Remove the cover (2) and gasket (3) from the body (11).

c. Unscrew the seal nut (10) and remove the relief valve seat (5), the relief valve (6), and the relief valve spring (8).

d. Remove the cartridge assembly (9).

4–66. CLEANING MAIN LUBE FILTER.

a. Dip all parts except the cartridge assembly and the gasket in cleaning solvent, Federal Specification P-S-661. If necessary, use a brush in order to clean the parts thoroughly. Allow the parts to drain and dry them with a lint-free cloth.

**CAUTION**

Do not use a wire brush on any part of the filter.

b. Blow through the openings in the cover with dry compressed air.

c. Clean the cartridge assembly with a soft hair brush dipped in the cleaning solvent.

d. Blow through the cartridge assembly from the center outward with dry compressed air.

4–67. ASSEMBLY OF MAIN LUBE FILTER. (See figure 4–12.)

a. Insert the cartridge assembly (9) in the body (11) so that it seats evenly in the circular groove.

b. Place the relief valve spring (8) over the stud (7).

c. Place the relief valve (6) over the stud.

**CAUTION**

The relief valve must be inserted with the projecting collar down.

d. Place the relief valve seat (5) over the relief valve with the recessed surface upward.

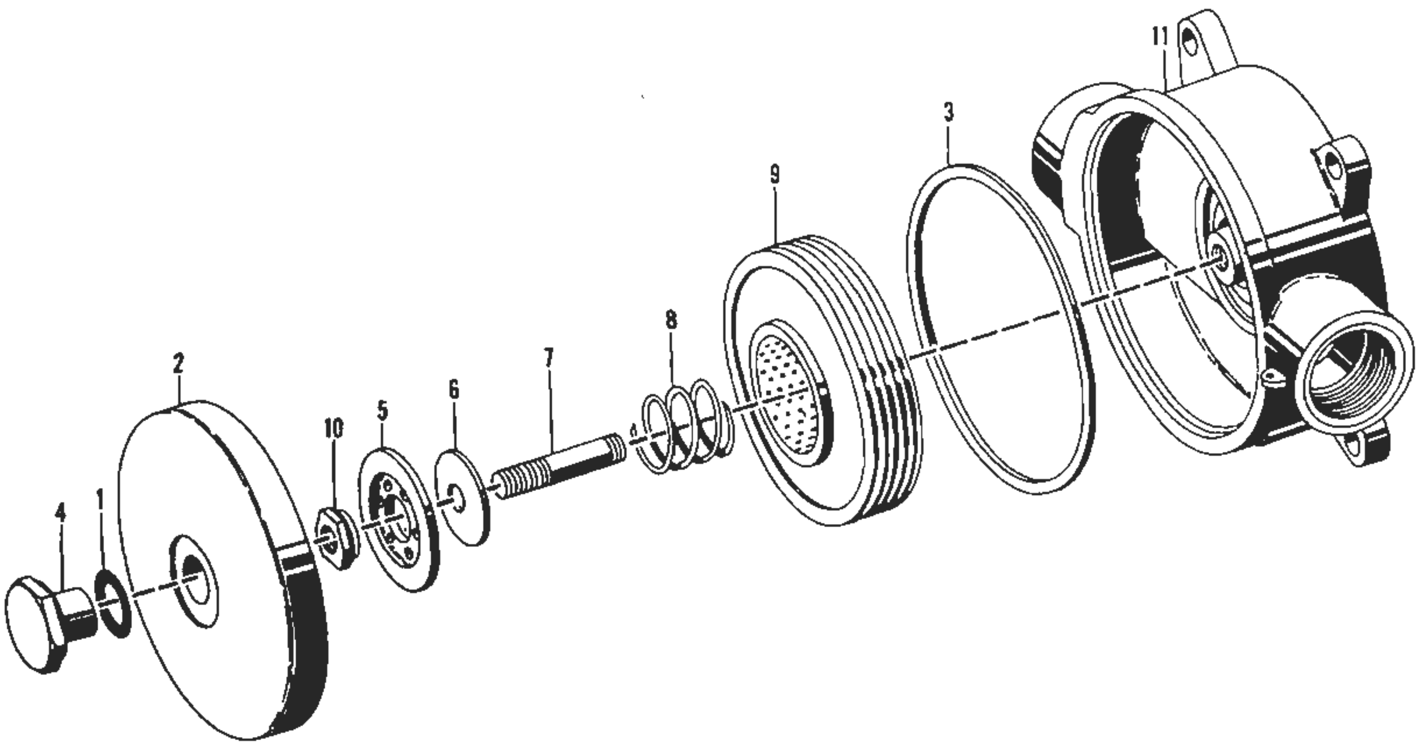
e. Place the seal nut (10) on the stud so that the projecting sleeve of the seal nut fits into the center opening of the relief valve seat (5). Turn the seal nut down until the valve seat bears firmly on the center section of the filter cartridge. Torque the seal nut (Reference No. 21, table XVII).

f. Install the gasket (3) in the recess in the body (11). Place the cover (2) on the body. Replace the packing (1), and secure it with the sleeve nut (4). Torque the sleeve nut (Reference No. 22, table XVII).

**4–68. MAINTENANCE OF FUEL SYSTEM COMPONENTS.**

4–69. FUEL CONTROL VALVE.

4–70. REMOVAL AND REPLACEMENT OF FUEL CONTROL VALVE. The removal and replacement procedure for the fuel control valve is given in paragraphs 4–34 and 4–35.




1. Packing
2. Cover
3. Gasket
4. Sleeve Nut
5. Relief Valve Seat
6. Relief Valve
7. Stud
8. Relief Valve Spring
9. Cartridge Assembly
10. Seal Nut
11. Body

*Figure 4–12. Main Lube Filter*

4–71. FUEL FILTER (AIR-MAZE MODELS 03S12166 and 03S12166D).

4–72. REMOVAL AND REPLACEMENT OF FUEL FILTER. The removal and replacement procedure for the fuel filter is given in paragraphs 4–34 and 4–35.

4–73. DISASSEMBLY OF FUEL FILTER. (See figure 4–13.)

a. Unscrew the sump (1) from the head assembly (14). Unscrew the cartridge assembly (2) and remove the "O" ring (9).

b. Dissassemble the cartridge assembly in the following way: remove the nut (5), tabwasher (6), and retainer cup (7). Remove the filter packs (3) and the spacers (4).

4–74. CLEANING FUEL FILTER.

a. Immerse all parts except the filter packs in cleaning solvent, Federal Specification P-S-661. If necessary, use a brush to clean the parts thoroughly. Allow the parts to drain and dry them with a lint-free cloth.

**CAUTION**

Do not use a wire brush on any part of the fuel filter.

b. Clean the filter packs with a soft hair brush dipped in the cleaning solvent.

c. Blow through all filter parts with dry compressed air.

4–75. ASSEMBLY OF FUEL FILTER. (See figure 4–13.)

a. Reassemble the cartridge assembly by alternately installing a filter pack (3) and a spacer (4) on the center tube assembly (8). Secure with the retainer cup (7), tabwasher (6), and nut (5). Torque the nut (Reference No. 29, table XVII).

b. Install the "O" ring (9) in the head assembly and screw the cartridge assembly (2) onto the head assembly. Torque the cartridge assembly (Reference No. 28, table XVII).

c. Screw the sump (1) onto the head assembly. Use anti-seize compound, Specification MIL-C-5544, on the sump threads. Torque the filter sump (Reference No. 30, table XVII).

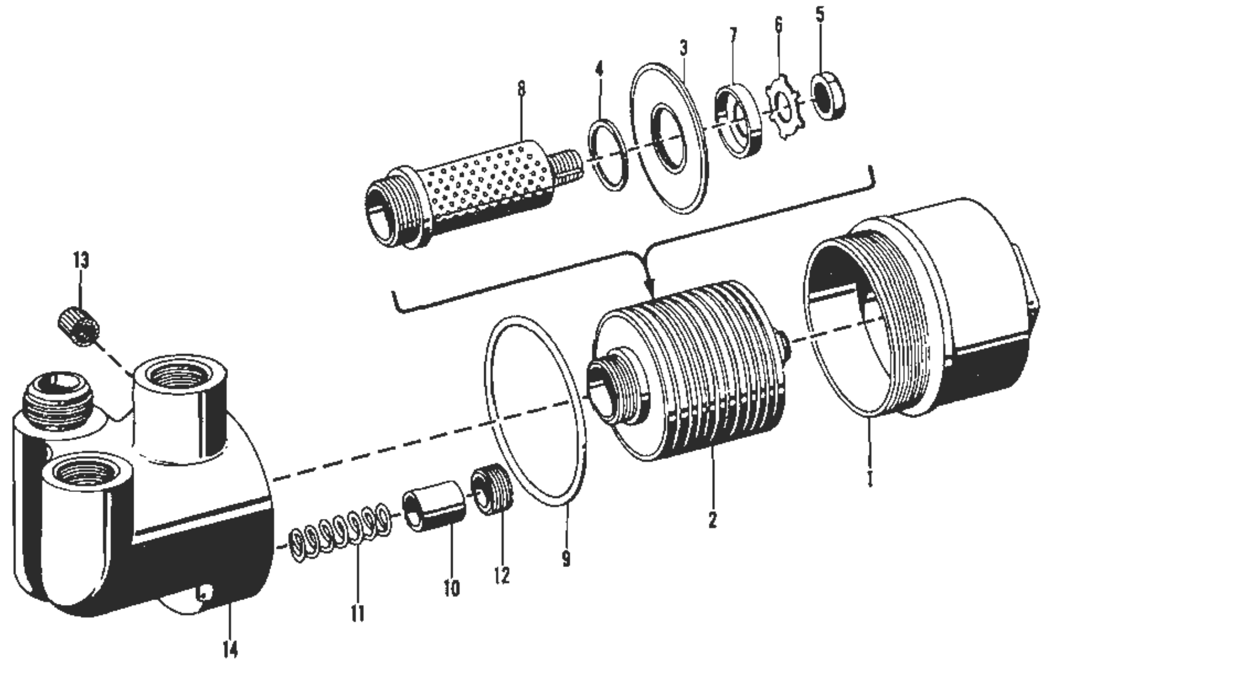
4–75A. FUEL FILTER (HYDRO-AIRE MODEL 3638A).

4–75B. REMOVAL AND REPLACEMENT OF FUEL FILTER. Same as for Air-Maze Models 03S12166 and 03S12166D. Refer to paragraphs 4–34 and 4–35.

4–75C. DISASSEMBLY OF FUEL FILTER. (See figure 4–13A.)

a. Remove the lockwire and unscrew the nut (6) from the bolt (8) and remove the washer (7).

b. Remove the bowl (10) and detach the ring (11) from the body assembly (20).




1. Sump
2. Cartridge Assembly
3. Filter Pack
4. Spacer
5. Nut
6. Tabwasher
7. Retainer Cup
8. Center Tube Assembly
9. "O" Ring
10. Relief Valve
11. Relief Valve Spring
12. Relief Valve Seat
13. Insert
14. Head Assembly

*Figure 4–13. Fuel Filter, Air-Maze Models 03S12166 and 03S1266D*

c. Remove the ring (12), washer (13), spring (14), washer (15) and ring (16) from the bolt (8).

d. Withdraw the cotter pin (9), and remove the seal (17) and ring (21) from the bolt (8).

e. Disassemble the filter element assembly by separating the 8 elements (19) and the 7 spacers (18), and remove the spacers and elements from the bolt.

**Note**

Filter element assemblies equipped with clips will have the clips removed and classified unserviceable. No new clips will be installed.

f. Remove the bolt (8) from the body assembly (20).

g. Remove the relief valve assembly by unscrewing the cap (1) and detaching the ring (2), washer (3), spring (4), and poppet assembly (5), from the body assembly (20).

4—75D. CLEANING OF FUEL FILTER. Same as for Air-Maze Models 03S12166 and 03S12166D. Refer to paragraph 4—74.

4—75E. ASSEMBLY OF FUEL FILTER.

a. Assemble the relief valve in the filter body assembly as shown in figure 4—13A (index No. 1 through 5).

b. Install the ring (21) on the bolt (8) and install the bolt and ring in the body assembly (20).

c. Assemble the 8 elements (19) and the 7 spacers (18) on the bolt (8) and install the seal (17) and the cotter pin (9) on the bolt.

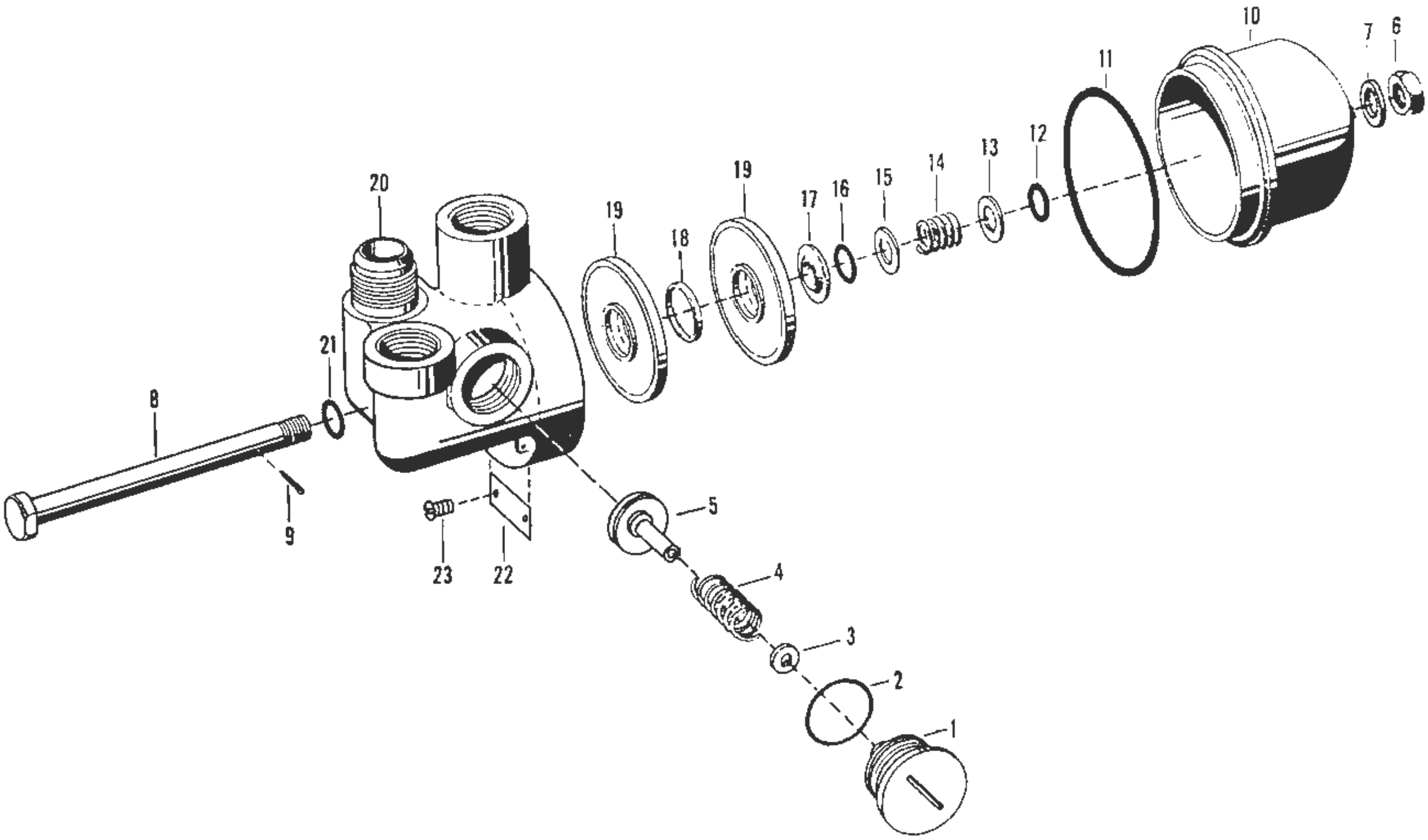
d. Install the ring (16), washer (15), spring (14), washer (13), and ring (12) on the bolt.

e. Assemble the bowl (10) to the body assembly (20) making sure the bowl is seated properly and is not pinching the ring, and install the washer (7) and the nut (6) on the bolt. Torque to 300-350 lb in.

4—76. STOPCOCK.

4—77. REMOVAL OF STOPCOCK.

a. Remove the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions given in paragraph 4—34.




1. Cap
2. Ring
3. Washer
4. Spring
5. Poppet Assembly
6. Nut
7. Washer
8. Bolt
9. Pin
10. Bowl
11. Ring
12. Ring
13. Washer
14. Spring
15. Washer
16. Ring
17. Seal
18. Spacer
19. Element Assembly
20. Body Assembly
21. Ring
22. Nameplate
23. Screw

*Figure 4—13A. Fuel Filter, Hydro-Aire Model 3638A*

b. Disconnect the stopcock control clevis from the stopcock. Disconnect the control lever rod and the stopcock lever rod from the clevis and remove the clevis.

c. Tag all stopcock hoses and their corresponding fittings to insure identical reassembly. Disconnect the hose lines.

d. Cut the lockwire and remove the stopcock from the main fuel regulator after removing 2 bolts and washers. After noting their position, remove the fittings from the stopcock.

4–78. REPLACEMENT OF STOPCOCK.

a. Install the hose fittings on the replacement stopcock but do not tighten them. Secure the stopcock to the main fuel regulator with 2 bolts and washers.

b. Connect all hose lines to their proper fittings and tighten the fittings. After the hoses are connected and the fittings tightened, secure the mounting bolts with twisted lockwire.

c. Install the stopcock control clevis on the spline of the stopcock shaft. If the old clevis does not fit, select one that does. Connect the control lever rod and the stopcock lever rod to the clevis.

d. Adjust the stopcock and main fuel regulator control linkage according to the instructions in paragraph 4–94. On model J47-11, -15 and -19 engines, adjust the linkage control pointer according to the instructions in paragraph 4–95.

e. Replace the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions in paragraph 4–35.

4–79. MAIN FUEL REGULATOR.

4–80. REMOVAL OF MAIN FUEL REGULATOR.

a. Remove the hydraulic pump drive gear case (J47-7 and -13) alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions given in paragraph 4–34.

b. Remove the stopcock from the main fuel regulator according to the instructions in paragraph 4–77.

c. Disconnect the regulator control clevis from the main fuel regulator manual control shaft and remove the clevis and the rod attached to it.

d. Disconnect the lines from the main fuel regulator after tagging them to insure identical reassembly.

e. Remove the main fuel regulator from the accessory drive gear box after removing 4 self-locking nuts and 4 washers. Remove the main fuel regulator gasket.

4–81. REPLACEMENT OF MAIN FUEL REGULATOR.

a. Mount the replacement main fuel regulator on the accessory drive gear box. Use a new gasket, and secure the regulator with 4 washers and 4 self-locking nuts. Do not tighten the nuts at this time.

b. Connect the lines to the main fuel regulator and tighten the fittings. The main fuel regulator mounting nuts may now be tightened.

c. Install the regulator control clevis on the main fuel regulator manual control shaft. The stopcock lever rod should still be attached to this clevis.

d. Install the stopcock on the main fuel regulator according to the instructions in paragraph 4–78.

e. Adjust the stopcock and main fuel regulator control linkage according to the instructions in paragraph 4–94. On model J47-11, -15, and -19 engines, adjust the linkage control pointer (paragraph 4–95) if necessary.

f. Replace the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions in paragraph 4–35.

4–82. MAIN AND EMERGENCY FUEL PUMPS.

**Note**

The emergency fuel pump is not used on model J47-11, -15, and -19 engines, since these do not incorporate an emergency fuel system.

4–83. REMOVAL OF MAIN OR EMERGENCY FUEL PUMP.

**Note**

The removal and replacement procedures are identical for the main and emergency fuel pumps, except that the 2 pumps are mounted at different locations on the accessory drive gear box and are connected to different fuel hose assemblies.

a. Remove the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount J47-11 and -19) according to the instructions given in paragraph 4–34.

b. Disconnect all fuel hoses to the pump after first tagging them to insure identical reassembly. Leave the fittings in place on the pump.

c. Remove 4 self-locking nuts and washers and remove the pump and its gasket from the accessory drive gear box. Note the position of the hose fittings before removing them from the pump.

4–84. REPLACEMENT OF MAIN OR EMERGENCY FUEL PUMP.

a. Install the hose fittings on the replacement pump but do not tighten them yet.

b. Mount the pump at the proper mounting pad on the accessory drive gear box. Use a new gasket, and secure the pump with 4 washers and 4 self-locking nuts. Do not tighten the nuts at this time.

c. Connect the fuel hoses to their proper fittings and tighten all connections. The pump mounting nuts may be tightened after the fuel hose connections are secured.

d. Replace the hydraulic pump drive gear case (J47-7 and -13), alternator pad assembly (J47-9 and -15), or accessory support mount (J47-11 and -19) according to the instructions in paragraph 4–35.

4–85. EMERGENCY FUEL REGULATOR (MODEL J47-7, -9, AND -13 ENGINES.

4–86. ADJUSTMENT OF EMERGENCY FUEL SYSTEM RECOVERY TIME. If emergency fuel system recovery time exceeds 3 seconds, as determined according to the procedure given in paragraph 1–76, replace the bleed plug in the emergency fuel regulator with the plug of the next smaller diameter. Table XV lists the part numbers and diameters of the bleed plugs supplied. Use new packing whenever the bleed plug is replaced. Recheck recovery time after the bleed plug is replaced. If necessary, repeat the procedure, using the next smaller bleed plug, until recovery time is within limits.

**CAUTION**

Do not attempt to obtain the absolute minimum recovery time (less than 3 seconds) because unstable operation of the emergency fuel regulator, as indicated by a violent fluctuation in fuel pressure and/or flow, may result. If unstable operation does occur, a bleed plug of larger diameter should be installed. If this does not provide satisfactory recovery time and stable operation, replace the emergency fuel regulator.

**TABLE XV**
**EMERGENCY FUEL REGULATOR BLEED PLUGS**

| Part No. | Diameter (in.) |
|---|---|
| 8734-1 | 0.1579 to 0.1581 |
| 8734-2 | 0.1569 to 0.1571 |
| 8734-3 | 0.1564 to 0.1566 |
| 8734-4 | 0.1559 to 0.1561 |
| 8734-5 | 0.1554 to 0.1556 |
| 8734-6 | 0.1549 to 0.1551 |

4–87. REMOVAL OF EMERGENCY FUEL REGULATOR.

a. Disconnect all fuel hoses at the emergency fuel regulator after first tagging them to insure identical reassembly. Leave the fittings in place on the regulator. Disconnect the electrical connection from the solenoid mounted on the emergency fuel regulator.

b. To disconnect the emergency control linkage, remove the cotter pin, nut, washer, and bolt, and remove the emergency control clamp from the manual shaft assembly on the emergency fuel regulator.

c. Remove 3 bolts, washers, and nuts, and remove the emergency fuel regulator from the brackets on the compressor front frame. Note the position of the hose fittings and remove them from the regulator.

4–88. REPLACEMENT OF EMERGENCY FUEL REGULATOR.

a. Install the hose fittings on the emergency fuel regulator but do not tighten them.

b. Secure the regulator to the mounting brackets on the compressor front frame with 3 bolts, washers, and nuts.

c. Attach the emergency control clamp to the manual shaft assembly with a bolt, washer, nut, and a new cotter pin. Do not bend the cotter pin until the linkage has been adjusted.

d. Connect the fuel hoses to their proper fittings on the emergency fuel regulator and tighten the fittings. Make the electrical connection to the solenoid mounted on the regulator.

e. Adjust the emergency fuel regulator control linkage according to the instructions in paragraph 4–96.

4–89. FLOW DIVIDER.

4–90. REMOVAL AND REPLACEMENT OF FLOW DIVIDER.

a. Disconnect the fuel hoses at the flow divider after tagging them to insure identical reassembly.

b. Remove 2 bolts and washers and remove the flow divider from the lower half of the compressor stator casing.

c. Replace the flow divider in the reverse order of removal.

4–91. FUEL NOZZLES.

4–92. REMOVAL AND REPLACEMENT OF FUEL NOZZLES.

a. Disconnect the large and small slot fuel manifold connections at the fuel nozzles.

b. To remove each fuel nozzle, remove 8 bolts and washers and the large slot fuel manifold support clamp. Remove the fuel nozzle and the fuel nozzle cover gasket.

**CAUTION**

Each fuel nozzle fits into a hole in the inner combustion chamber. Use care in working the nozzle loose to prevent damage to the nozzle tip.

c. Cover all openings with suitable caps.

d. Replace the fuel nozzles in the reverse order of removal. Use new fuel nozzle cover gaskets.

4–93. ADJUSTMENT OF FUEL CONTROL LINKAGE.

4–94. ADJUSTMENT OF STOPCOCK AND MAIN FUEL REGULATOR CONTROL LINKAGE. (See figure 4–14.)

a. The control lever rod (1) extends between the stopcock control clevis (3) and the control shaft clevis (6). Make sure that the control shaft clevis points in the same general direction as the regulator control clevis (4).

b. Adjust the length of the control lever rod so that the distance between the center of the hole in the outer fork of the control shaft clevis and the machined forward face of the gear case is 1.095 to 1.125 inches.

c. Adjust the bearing at the end of the control lever rod so that there will be no binding or interference with the control shaft clevis in the idle speed position, and

no slippage past center in the high speed position. Tighten the locking nuts (8).

**Note**

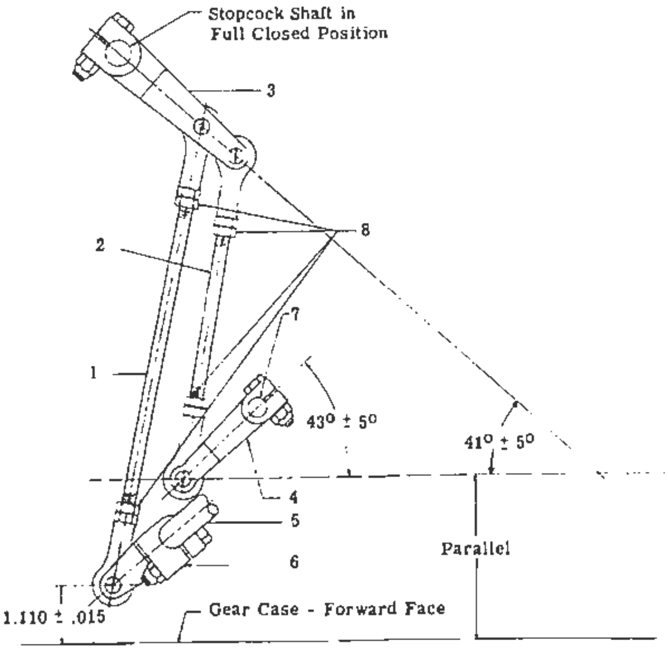
If necessary, the 2 control shaft rod end bearings should be shimmed to make a snug but movable fit in the bearing mountings. The control shaft should rotate freely in the bearings.

d. Rotate the stopcock shaft clockwise to the full-closed position. Loosen the stopcock control clevis and position it on the stopcock shaft so that the centerline of the clevis makes an angle of 36 to 46 degrees with the mounting surface of the gear case when a closing torque of approximately 20 lb in. is applied. Tighten the clevis at this position.

e. Rotate the main fuel regulator manual control shaft (7) counterclockwise to the full-closed position. Loosen the regulator control clevis and position it on the manual control shaft so that the centerline of the clevis makes an angle of 38 to 48 degrees with the mounting surface of the gear case. Tighten the clevis at this position.

f. Adjust the length of the stopcock lever rod (2) between the stopcock control clevis and the regulator control clevis so that when the stopcock is closed with a torque of 20 lb in., the main fuel regulator is also closed.

g. Disconnect one end of the stopcock lever rod. On engines equipped with a No. VS2-6900-G5 or -G6 main fuel regulator and a No. 8992757 or 9482366 stopcock, shorten the rod length by 2 turns, so that the main fuel




1. Control Lever Rod
2. Stopcock Lever Rod
3. Stopcock Control Clevis
4. Regulator Control Clevis
5. Control Shaft
6. Control Shaft Clevis
7. Main Fuel Regulator Manual Control Shaft
8. Locking Nuts

***Figure 4–14. Stopcock and Main Fuel Regulator Control Linkage***

regulator will be opened approximately 3 degrees when the stopcock is closed. On engines equipped with a No. VS2-6900-F4 or -F5 main fuel regulator and a No. 8482486 stopcock, shorten the length of the stopcock lever rod by 6 turns, opening the regulator approximately 6 degrees. Reconnect the stopcock lever rod to the clevis from which it was detached and tighten the locking nuts (8).

**Note**

The thread engagement at both ends of the rod should be equal within 1/8 inch after all adjustments are completed. This also applies to the control lever rod.

h. The high speed stop may be changed by turning the screw on the No. 4 island cover in or out. One turn of the screw is equivalent to approximately 75 (0.94 percent) rpm.

**Note**

Do not reset the high speed stop screw unless testing after service (paragraph 4–99) indicates that 100 percent rpm is not available on the main fuel system or is exceeded.

### 4–95. ADJUSTMENT OF LINKAGE CONTROL POINTER (MODEL J47-11, -15, AND -19 ENGINES). (See figure 4–15.)

a. Check that the 2 bolts which secure the graduated stopcock and regulator escutcheon plate (8) to the No. 4 island cover are centered in the plate slots. Loosen the bolts and adjust the plate if necessary.

b. Rotate the control shaft counterclockwise to the full-closed position of the stopcock.

c. Loosen the linkage control pointer (7) which engages the high speed stop on the No. 4 island cover. On engines with a No. VS2-6900-G5 or -G6 main fuel regulator, position the pointer on the control shaft so that the centerline through the section which engages the high speed stop makes an angle of 75 to 85 degrees (angle "X") with the forward flange of the compressor front frame. On engines equipped with a No. VS2-6900-F4 or -F5 main fuel regulator, angle "X" should be 70 to 80 degrees. In both cases, the pointer itself should be in the approximate center of the "OFF" sector of the escutcheon plate.

d. The high speed stop may be changed by turning the screw on the No. 4 island cover in or out. One turn of the screw is equivalent to approximately 75 (0.94 percent) rpm.

**Note**

Do not reset the high speed stop screw unless testing after service (paragraph 4–99) indicates that 100 percent rpm is not available or is exceeded.

### 4–96. ADJUSTMENT OF EMERGENCY FUEL REGULATOR CONTROL LINKAGE (MODEL J47-7, -9, AND -13 ENGINES). (See figure 4–15.)

a. Check that the 2 bolts which secure the graduated stopcock and regulator escutcheon plate (8) to the No.

4 island cover are centered in the plate slots. Loosen the bolts and adjust the plate if necessary.

b. Rotate the control shaft counterclockwise to the full-closed position of the stopcock. Remove the emergency control rod (6) with its rod end bearings from the linkage assembly.

c. Loosen the stopcock and regulator pointer (7) and the emergency control clevis (1) which engages the high speed stop on the No. 4 island. On engines with a No. VS2-6900-G5 or -G6 main fuel regulator, position the emergency control clevis on the control shaft so that its centerline makes an angle of 75 to 85 degrees (angle "X") with the forward flange of the compressor front frame. On engines with a No. VS2-6900-F4 or -F5 main fuel regulator, angle "X" should be 70 to 80 degrees. In both cases, the pointer should be in the approximate center of the "OFF" sector of the escutcheon plate. Tighten the pointer and the clevis.

d. Rotate the emergency fuel regulator manual shaft (2) counterclockwise until it engages an internal stop at the full-open position.

e. Loosen the emergency control adjustable clevis (3) and position it so that the centerline of the clevis makes an angle of 17 to 27 degrees with the forward flange of the compressor front frame. Tighten the clevis.

f. Loosen the emergency control clamp on the emergency fuel regulator manual shaft and position it so that the distance between the centerline of the hole in the clamp and the centerline of the holes in the adjustable clevis is 1-5/8 ±1/32 inches. This is the same as the distance between the holes in the emergency control clevis. Tighten the clamp.

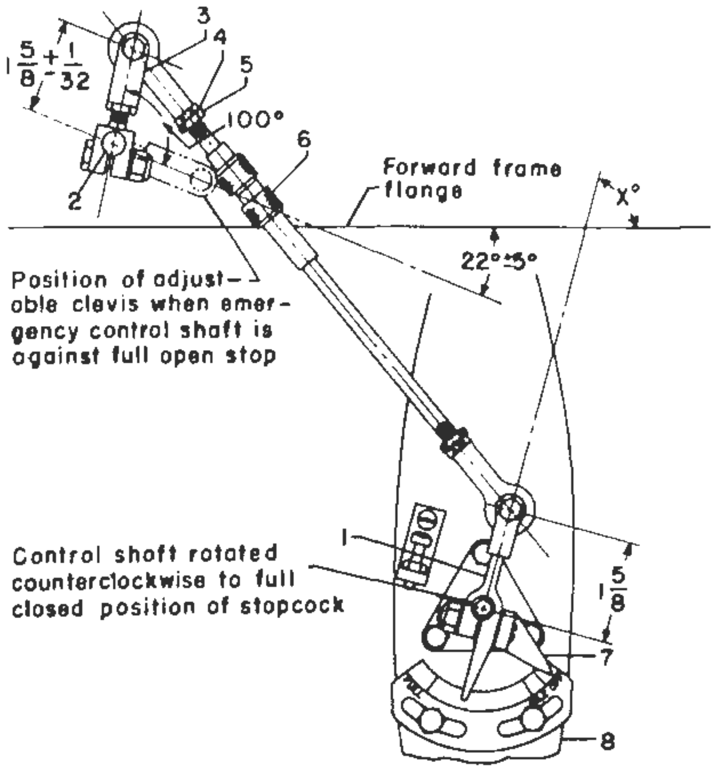
g. Rotate the emergency control clevis and the pointer approximately 90 degrees clockwise until the pointer is in the center of the "FULL" sector of the graduated escutcheon plate. The high speed stop screw on the No. 4 island cover should limit the travel of the emergency control clevis at this point.

h. Insert tabwashers (4) between the rod end bearings and the locking nuts (5) on the emergency control rod (6). Bend 2 of the tabs on each tabwasher over the flats on the rod end bearings. Do not bend the other tabs at this time.

i. Turn the rod end bearing which mates with the emergency control adjustable clevis 3 complete turns past the sight hole provided in the bearing. Tighten the locking nut (5).

j. With the emergency control clevis held against the high speed stop and the emergency fuel regulator manual shaft cam held at 90 degrees on the emergency fuel regulator graduated quadrant plate, adjust the length of the emergency control rod and assemble it to the emergency control clevis and the adjustable clevis.

k. Rotate the emergency control clevis until the pointer is at the "OFF" position on the escutcheon plate. Disconnect the emergency control rod at either end and check the adjustable clevis to make sure there is free travel in a counterclockwise direction to the internal stop in the emergency fuel regulator. Reconnect the emergency control rod and check to see that the emergency control clevis reaches its stop just before the adjustable clevis reaches its internal stop. If the adjustable clevis reaches its stop before the emergency control clevis, shorten the emergency control rod as required to correct this condition.




1. Emergency Control Clevis
2. Emergency Fuel Regulator Manual Shaft
3. Emergency Control Adjustable Clevis
4. Tabwasher
5. Locking Nut
6. Emergency Control Rod
7. Linkage Control Pointer (J47-11, -15, and -19) Stopcock and Regulator Pointer (J47-7, -9, and -13)
8. Stopcock and Regulator Escutcheon Plate

*Figure 4—15. Emergency Fuel Regulator Control Linkage*

**Note**

Do not use the above setting procedure on engines equipped with a model -D2 or -D3 emergency fuel regulator. (The result would be that after the emergency fuel system high speed stop was set, the emergency fuel regulator manual control shaft would reach its internal low speed stop before the stopcock was fully closed, since the manual shaft of these models does not have 10 or 12 degrees negative travel.) Send all -D2 and -D3 emergency fuel regulators to an approved AMC activity for rework and install a later model emergency fuel regulator.

l. Adjustment of maximum speed for operation on the emergency fuel system may be made by lengthening or shortening the emergency control rod. One complete revolution of the rod is equivalent to approximately 150 (1.88 percent) rpm.

**Note**

Do not alter the length of the emergency control rod unless testing after service (paragraph 4—100) indicates that maximum speed on the emergency fuel system is not within limits.

4—97. LINKAGE CHECK.

a. Operate the linkage assembly from the "OFF" to the "FULL" position and check all rod linkages. The linkage should move freely and the connecting rods should show no evidence of binding.

b. Operate the engine to check that 100 percent rpm is available on the main fuel system according to the instructions given in paragraph 4—99. Reset the high speed stop if necessary (paragraph 4—94, step "h," or 4—95, step "d").

c. On all model J47-7, -9, and -13 engines, check operation on the emergency fuel system according to the instructions given in paragraph 4—100 in order to determine that maximum speed is within limits. Adjust maximum speed if necessary (paragraph 4—96 step "l"). After maximum speed on the emergency fuel system is within limits, bend the 4 free tabs on each tab-washer (4, figure 4—15) over the flats of the locking nuts (5) on the emergency control rod (6).

## 4—98. TESTING AFTER SERVICE.

4—99. Start and operate the engine in accordance with the instructions given in paragraphs 1—69 and 1—70. Check exhaust gas temperatures (paragraphs 1—66 and 1—67) and adjust the jet nozzle area if necessary (paragraph 1—75). Check that 100 percent rpm is available when operating on the main fuel system, and adjust the high speed stop screw if necessary (paragraph 4—94, step "h," or 4—95, step "d"). On engines equipped with a No. VS2-6900-G5, -G6, or later model main fuel regulator, make the throttle burst check described in paragraph 1—74.

4—100. On model J47-7, -9, and -13 engines, perform the emergency fuel system preflight operational check described in paragraph 1—76. Maximum speed on the emergency fuel system should be 99 percent rpm or slightly below, and must be within one percent of the curve shown in figure 4—16. If necessary, adjust top speed on the emergency fuel system according to the instructions in paragraph 4—96, step "l."

## 4—101. TORQUE VALUES.

4—102. GENERAL. The torque values for specific parts are listed in table XVII according to the name of the part. All bolts, nuts, fittings, etc, not listed in this table or in paragraph 4—106 are to be tightened to the standard torque values given in tables XVIII through XXIII, where the values are listed according to the type, material, and size of the part to be torqued.

4—103. TORQUE WRENCHES. Obtain all torque values with the proper torquing tools. Use a torque wrench suitable to the part being tightened. Suggested torque wrench sizes are listed in table XVI. Calibrate torque wrenches periodically to insure accuracy, and apply correction factors to torque readings when extensions are used.

**TABLE XVI**
**SUGGESTED TORQUE WRENCH SIZES**

| Torque | Torque Wrench | Tolerance |
|---|---|---|
| 0—25 lb in. | 30 lb in. | ± 1 lb in. |
| 25—140 lb in. | 150 lb in. | ± 8 lb in. |
| 140—550 lb in. | 600 lb in. | ± 20 lb in. |
| 30—140 lb ft | 150 lb ft | ± 5 lb ft |
| 140—240 lb ft | 250 lb ft | ± 10 lb ft |
| 240—1000 lb ft | 1000 lb ft | ± 20 lb ft |

4—104. TORQUE PROCEDURES.

a. Seat mating parts properly and run nuts or bolts down using a staggered sequence. After parts are properly seated, apply final tightening in a series of gradually increasing values until the maximum torque is obtained. Use a staggered sequence for final tightening.

**CAUTION**

Do not exceed the maximum torque value during the seating process or overstressing and/or distortion may result. Do not tighten to final value during the first drawdown, as this may cause uneven tension, overstressing of parts, and may result in distorted split-line surfaces.

b. Torque castle nuts or nuts with tab lockwashers to the minimum value and then tighten to the next locking position. If this cannot be done without exceeding the maximum torque, use washers, nuts, and/or bolts to obtain final torque.

**CAUTION**

Do not exceed the listed torque values more than necessary, as overstressing of the bolt or part may result.

c. All studs shall be coated with anti-seize compound, Specification JAN-A-669, or zinc-chromate primer, Specification MIL-P-6889A, prior to installation into magnesium. Plated studs may be installed into aluminum without the use of any compound or primer, but unplated studs for installation into aluminum shall be coated with either the anti-seize compound or the zinc-chromate primer.

4—105. TORQUE VALUES FOR SPECIFIC PARTS. Table XVII lists torque values for specific engine parts and accessories or auxiliary components. The items are grouped within this table according to the section of the engine in which the part is used. Refer also to paragraph 4—106.

**Note**

All items marked with an asterisk (*) in table XVII require the special torque values listed in the table for reasons of strength, fit, or function of the part. The torque values for all other items are standard, but included in this table for easy reference and convenience.

The reference numbers given in the first column of the table have been used throughout this handbook in referring to these special and standard torque values.

4—106. TORQUE VALUES FOR MISCELLANEOUS FITTINGS, NUTS, AND BOLTS.

a. Aluminum universal (Banjo) fittings used with AN-4 (1/4-inch) tubing should be tightened to a torque of 100 lb in. when assembled with aluminum gaskets, and a torque of 125 lb in. when assembled with steel gaskets.

b. The torque for AN815-12 unions used with silicone gaskets is 120 to 130 lb in.

c. Pal nuts should be tightened finger tight plus one-quarter turn.

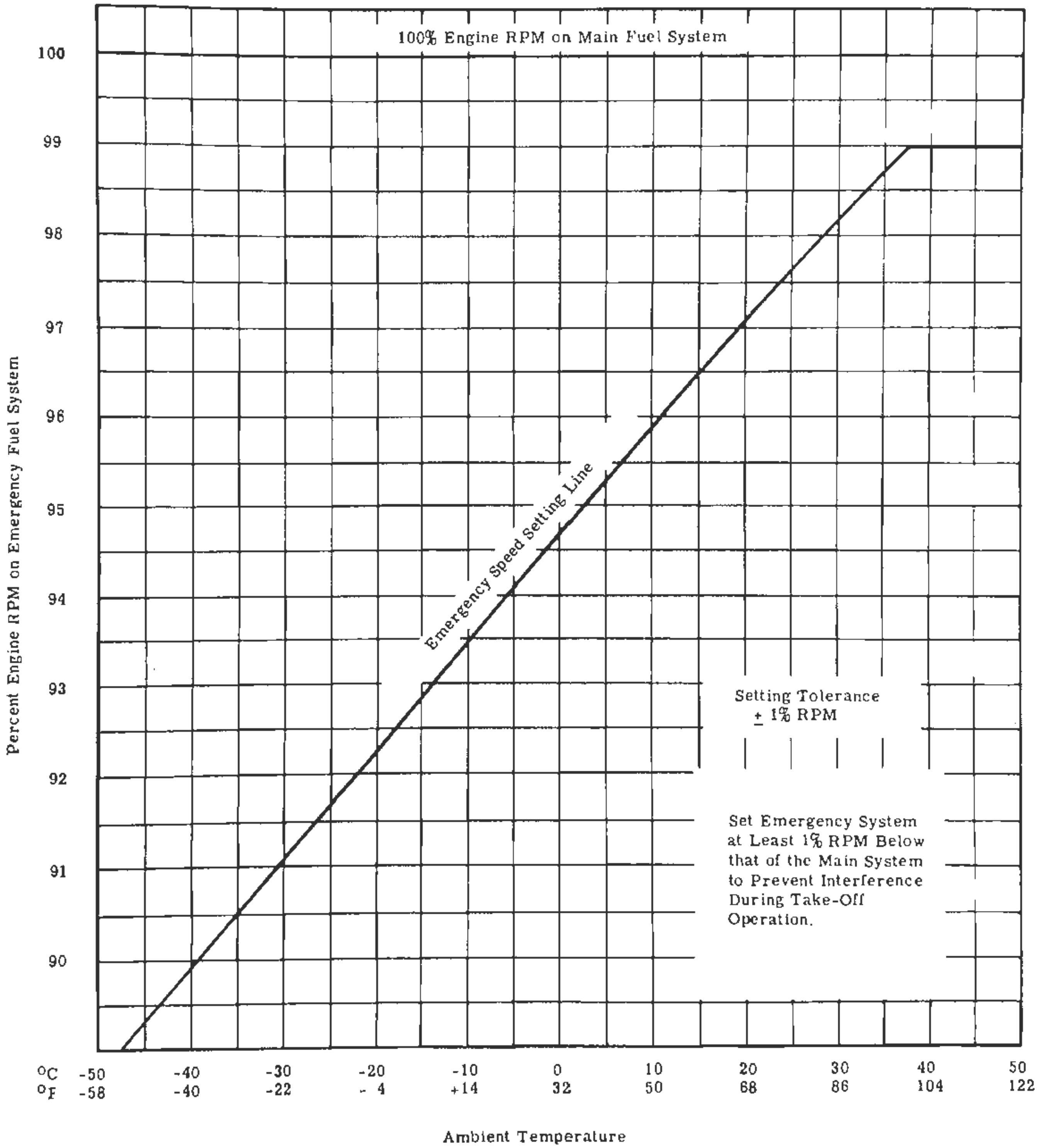



*Figure 4—16. Emergency Fuel System Speed Setting Chart*

## TABLE XVII

## TORQUE VALUES FOR SPECIFIC PARTS

| Reference Number | Part Nomenclature | Thread Size | Torque |
|---|---|---|---|
| | **POWER TAKE-OFF AND ACCESSORY DRIVE SECTIONS** | | |
| 6 | Nut, self-locking – Hydraulic pump drive gear case vertical flange | 1/4–28<br>5/16–24 | 60–95 lb in.<br>130–180 lb in. |
| 7 | Plug, drain – Hydraulic pump drive gear case | 7/16–20 | 145–180 lb in. |
| 8 | Nut, self-locking – Power take-off mounting bolt | 3/8–24 | 260–320 lb in. |
| 9 | *Bolt, internal-wrenching – Power take-off | 1/4–28 | 60–95 lb in. |
| 10 | *Plug, drain, magnetic – Accessory drive gear box | 1-1/16–12 | 400 lb in. |
| 11 | Fitting, threaded – Accessory drive gear box<br>With leather-type gaskets<br>**Note**<br>Use anti-seize compound, Specification JAN-A-669.<br>With rubber gaskets | ––<br><br><br><br>–– | 330 lb in.<br><br><br><br>100 lb in. |
| | **ACCESSORIES** | | |
| 12 | Nut, self-locking – Starter-generator mounting | 3/8–24 | 260–320 lb in. |
| 13 | Nut, self-locking – Main fuel regulator mounting | 5/16–24 | 130–180 lb in. |
| 14 | *Nut, self-locking – Emergency fuel regulator mounting | 1/4–28 | 25–30 lb in. |
| 15 | Nut, self-locking – Main fuel pump mounting | 5/16–24 | 130–180 lb in. |
| 16 | Nut, self-locking – Emergency fuel pump mounting | 5/16–24 | 130–180 lb in. |
| 17 | Bolt – Main lube pump mounting | 5/16–24 | 80–130 lb in. |
| 18 | Nut, self-locking – Tachometer-generator mounting | 1/4–28 | 60–95 lb in. |
| 19 | *Bolt – Aft scavenge pump mounting | 5/16–24 | 105 lb in. |
| 20 | Plug, drain – Oil cooler | 1/2–20 | 150–175 lb in. |
| 21 | *Nut, seal – No. C15575K main lube filter | 5/16–24 | 25–30 lb in. |
| 22 | *Nut, sleeve – No. C15575K main lube filter | 5/16–24 | 70–80 lb in. |
| 23 | *Nut, cover – No. 3690 main lube filter | –– | 50–70 lb in. |
| 24 | *Strainer assembly – No. OS12223G regulator oil filter and orifice | 9/16–18 | 40–50 lb in. |
| 25 | *Nut, retainer cup – No. OS12223G regulator oil filter and orifice | 10–32 | 10–15 lb in. |
| 26 | *Sump – No. OS12223G regulator oil filter and orifice | 1-5/8–12 | 10–14 lb ft |
| 27 | *Nut, self-locking – No. 3856 regulator oil filter and orifice | –– | 40–60 lb in. |
| 28 | *Cartridge assembly – No. 03S12166D fuel filter | 1-1/4–18 | 75–90 lb in. |
| 29 | *Nut, retainer cup – No. 03S12166D fuel filter | 5/8–24 | 30–35 lb in. |
| 30 | *Sump – No. 03S12166D fuel filter | 3-1/2–12 | 170–200 lb in. |
| 31 | *Nut, bowl – No. 3638A fuel filter | –– | 300–350 lb in. |
| | **COMPRESSOR SECTION** | | |
| 32 | *Nut – Compressor stator casing horizontal split-line flange | 7/16–20 | 140–180 lb in. |
| 33 | Nut, self-locking – Compressor stator casing to front frame | 3/8–24 | 160–240 lb in. |
| 34 | *Bolt, cap (AN76-7) – Compressor stator casing to front frame | 3/8–24 | 105 lb in. |

TABLE XVII (Cont)

| Reference Number | Part Nomenclature | Thread Size | Torque |
|---|---|---|---|
| 35 | Nut, self-locking — Compressor stator casing to rear frame | 3/8—24 | 160—240 lb in. |
| 36 | *Bolt — Fuel nozzle to rear frame | 1/4—28 | 18—35 lb in. |
| 37 | *Plug, drain — Rear frame oil pump | 1/2—20 | 110 lb in. |
| 38 | *Union — Aft scavenge pump | —— | 125 lb in. |
| 39 | *Nut, retaining — Thermocouple harness to rear frame | —— | 55 lb in. |
| | **TURBINE SECTION** | | |
| 40 | *Nut — Combustion chamber Marman clamp | | |
| | Standard | 1/4—28 | 50—60 lb in. |
| | Self-locking | 1/4—28 | 45—50 lb in. |
| | **Note** Use anti-seize compound, Specification MIL-C-5544. | | |
| 41 | *Bolt — Combustion chamber | 1/4—20 | 25—30 lb in. |
| 42 | *Nut, special slotted (lug) — Combustion chamber fuel drain fittings | 7/16—20 | 170—200 lb in. |
| 43 | *Lug, wear — Combustion chamber (early model J47-19 engines only) | —— | 40—100 lb in. |
| 44 | *Bolt — Cross-ignition tube | | |
| | Model J47-7, -9, -11, -13, and -15 engines | 1/4—20 | 40—50 lb in. |
| | Model J47-19 engines | 1/4—20 | 60—75 lb in. |
| 45 | *Nut, self-locking — Exhaust cone to nozzle diaphragm ring or turbine casing | 1/4—28 | 18—35 lb in. |
| 46 | *Bolt — Tailpipe Marman clamp | 1/2—13 | Torque to 130—140 lb in. Loosen and retorque to 70—75 lb in. Do not retorque thereafter. |
| 47 | *Cap — Exhaust cone thermocouple boss | —— | 40—50 lb in. |
| | **EXTERNAL PIPING AND WIRING** | | |
| 48 | *Nut, coupling — Turbine rotor to exhaust cone cooling air tube flare fitting | 1-5/16—12 | 35 lb ft |
| 49 | *Nut, packing — Turbine rotor cooling air tube | 1-7/8—12 | 230—280 lb in. |
| 50 | *Elbow — Fuel nozzle small slot | 7/16—20 | 100 lb in. |
| 51 | *Elbow — Fuel nozzle large slot | 1/2—20 | 200 lb in. |
| 52 | *Nut, coupling — Fuel nozzle small slot flexible jumper line | 7/16—20 | 40 lb in. |
| 53 | *Nut, coupling — Fuel nozzle large slot flexible jumper line | 9/16—18 | 75 lb in. |
| 54 | *Nut, Raybould coupling — Aft scavenge pump | 1-1/4—18 | 125 lb in. |
| 55 | *Union — Cooling air tube between No. 1 and 2 combustion chambers | —— | Tighten to a snug slip fit. |
| 56 | *Cap, flared — Combustion chamber manifold | 9/16—18 | 125 lb in. |
| 57 | *Nut, coupling — Power take-off drive shaft housing drain | 7/16—20<br>9/16—18 | 24—26 lb in.<br>50 lb in. |
| 58 | Nut, packing — Igniter plug | —— | 90—125 lb in. |
| 59 | Nut, packing — Igniter plug lead | —— | 225 lb in. (min) |

d. To assemble the strongback on the engine for shipment, the strongback bolt should be torqued to 50 lb in. and then backed off and retorqued to 25 lb in.

4–107. TORQUE VALUES FOR STANDARD STEEL BOLTS AND NUTS. Use the torque values given in table XVIII for standard steel bolts and nuts.

**Note**

Use one-half of the torque value given in table XVIII for all bolts threaded directly into aluminum, magnesium, or other nonferrous alloys.

**TABLE XVIII**

**TORQUE VALUES FOR STANDARD STEEL BOLTS AND NUTS**

| NC and 8 Thread Series | Torque | NF and 12 Thread Series | Torque |
|---|---|---|---|
| 8–32 | 13–16 lb in. | 8–36 | 16–19 lb in. |
| 10–24 | 20–23 lb in. | 10–32 | 24–27 lb in. |
| 1/4–20 | 30–60 lb in. | 1/4–28 | 35–70 lb in. |
| 5/16–18 | 70–110 lb in. | 5/16–24 | 80–130 lb in. |
| 3/8–16 | 160–210 lb in. | 3/8–24 | 190–230 lb in. |
| 7/16–14 | 250–320 lb in. | 7/16–20 | 290–360 lb in. |
| 1/2–13 | 420–510 lb in. | 1/2–20 | 480–570 lb in. |
| 9/16–12 | 48–57 lb ft | 9/16–18 | 55–65 lb ft |
| 5/8–11 | 70–80 lb ft | 5/8–18 | 82–95 lb ft |
| 3/4–10 | 135–150 lb ft | 3/4–16 | 150–165 lb ft |
| 7/8–9 | 205–230 lb ft | 7/8–14 | 235–265 lb ft |
| 1–8 | 300–340 lb ft | 1–14 | 350–400 lb ft |
| 1-1/8–7 | 415–480 lb ft | 1-1/8–12 | 485–565 lb ft |
| 1-1/4–7 | 600–700 lb ft | 1-1/4–12 | 690–800 lb ft |
| 1-1/2–6 | 1000–1200 lb ft | 1-1/2–12 | 1200–1400 lb ft |
| 1-1/8–8 | 440–510 lb ft | | |
| 1-1/4–8 | 625–725 lb ft | | |
| 1-1/2–8 | 1150–1350 lb ft | | |

4–108. TORQUE VALUES FOR THIN STEEL HEX NUTS. For thin steel hex nuts, use one-half the torque value listed in table XVIII for standard steel bolts and nuts.

4–109. TORQUE VALUES FOR NONFERROUS NUTS AND BOLTS. For nonferrous nuts and bolts, use one-half the torque value given in table XVIII for standard steel nuts and bolts.

4–110. TORQUE VALUES FOR SELF-LOCKING NUTS. Use the torque values given in table XIX for self-locking nuts.

**TABLE XIX**

**TORQUE VALUES FOR SELF-LOCKING NUTS**

| Size and Thread | Torque Standard | Torque Silver-plated |
|---|---|---|
| 10–32 | 30–45 lb in. | |
| 1/4–28 | 60–95 lb in. | 36–70 lb in. |
| 5/16–24 | 130–180 lb in. | 80–130 lb in. |
| 3/8–24 | 260–320 lb in. | 190–230 lb in. |
| 7/16–20 | 400–490 lb in. | 290–360 lb in. |
| 1/2–20 | 53–62 lb ft | |

4–111. TORQUE VALUES FOR STUDS INSTALLED INTO ALUMINUM OR MAGNESIUM. Table XX gives torque values for studs and stepped studs installed into aluminum or magnesium which are not held in position by a locking device other than an interference fit.

**CAUTION**

Do not exceed the values given in table XX. Some approach the yield point of the material.

**Note**

Studs which are manufactured to 2 different thread sizes on opposite ends shall be torqued to the value given for the smaller thread size in table XX.

**TABLE XX**

**TORQUE VALUES FOR STUDS INSTALLED IN ALUMINUM OR MAGNESIUM**

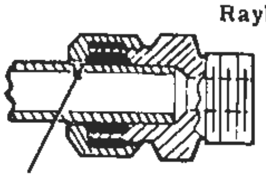
| Size and Thread | Torque |
|---|---|
| 10–24 | 35 lb in. |
| 1/4–20 | 75 lb in. |
| 5/16–18 | 135 lb in. |
| 3/8–16 | 240 lb in. |
| 7/16–14 | 370 lb in. |
| 1/2–13 | 560 lb in. |

4–112. TORQUE VALUES FOR FLARED TUBING AND HOSE FITTINGS. Torque flared tubing and hose fittings to the values given in table XXI.

**Note**

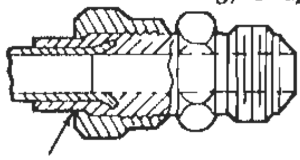
Use steel torque values only when nut, line fitting, and sleeve are all steel. In all other cases, use the value for aluminum or alloy. Painted and plated parts may not be steel, so make sure before using steel torque values.

Raybould Fitting



Lubricate mating surfaces with mineral oil.

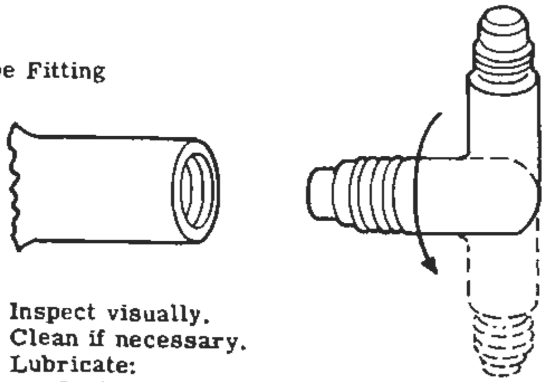
Flared Tubing, Coupling Nut, and Fitting



Lubricate mating surfaces with mineral oil and:

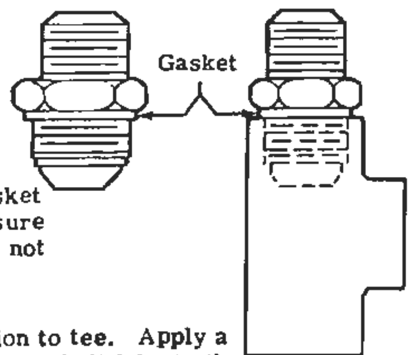
1. Run nut down to full torque.
2. Back off one quarter turn.
3. Retighten to full-torque value.

Pipe Fitting



1. Inspect visually.
2. Clean if necessary.
3. Lubricate:
   a. On fittings used on compressor casings and gear sets, use bolt lube No. 205 or equivalent.
   b. On fittings used on aft frames, use Crane's compound No. 425.
4. Assemble fitting, screwing down to within one-half turn of final position.
5. Remove, clean and inspect male thread.
6. Relubricate.
7. Reassemble and screw down to final position.

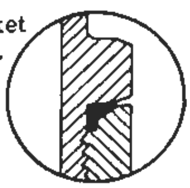
Union



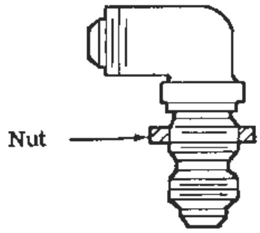

1. Assemble gasket to union making sure that the gasket is not twisted.

2. Assemble union to tee. Apply a very small amount of bolt lube to the threads and tighten to the proper torque value.

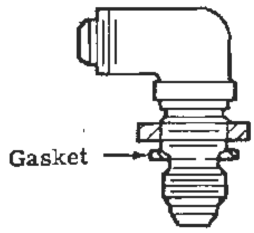
Correct compression of gasket with properly torqued fitting.



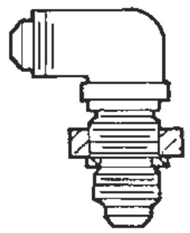
Bulkhead Fitting



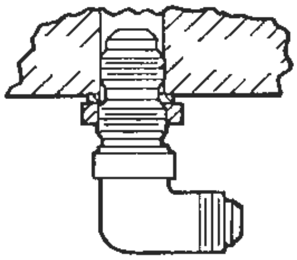

1. Assemble nut on fitting and turn it well up on the upper thread. Apply a very small amount of bolt lube to the threads.




2. Assemble the gasket snugly against the upper threads and make sure the gasket is not twisted.

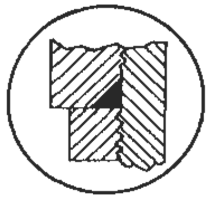


3. Run the nut down until it just touches the gasket.



4. Assemble the fitting into the casting until the gasket just contacts the casting. If the position of the fitting is not correct, back out (counterclockwise) until the fitting is in the proper position. Tighten nut to proper torque value.

CAUTION-Do not back out more than one turn.



Correct compression of gasket with properly torqued nut

*Figure 4—17. Assembling Tubing and Allied Fittings*

**TABLE XXI**

**TORQUE VALUES FOR FLARED TUBING AND HOSE FITTINGS**

| Tube OD (in.) | Flexible Tube AN Dash No. | Torque: Aluminum or Alloy | Torque: Steel |
|---|---|---|---|
| 1/4 | 4 | 55 lb in. | 125 lb in. |
| 3/8 | 6 | 100 lb in. | 225 lb in. |
| 1/2 | 8 | 210 lb in. | 365 lb in. |
| 5/8 | 10 | 300 lb in. | 525 lb in. |
| 3/4 | 12 | 35 lb ft | 60 lb ft |
| 1 | 16 | 50 lb ft | 100 lb ft |
| 1-1/4 | 20 | 60 lb ft | |
| 1-1/2 | 24 | 75 lb ft | |

4–113. TORQUE VALUES FOR FITTINGS USED WITH GASKETS. Assemble fittings used with gaskets as shown in figure 4–16. Use the torque values given in table XXII.

4–114. TORQUE VALUES FOR BULKHEAD FITTINGS USED WITHOUT GASKETS. When passing aluminum and nonferrous alloy bulkhead fittings through walls where no gasket seal is used, use the torque values given in table XXII. Increase these values by 50 percent when steel fittings without gaskets are used.

4–115. TORQUE VALUES FOR JAM NUTS FOR FITTINGS USED WITHOUT GASKETS. Torque jam nuts for fittings used without gaskets to the values given in table XXIII.

**Note**

Use torque values for steel only when both mating parts are steel. Use torque values for aluminum or alloy in all other cases.

**TABLE XXII**

**TORQUE VALUES FOR FITTINGS USED WITH GASKETS**

| Fitting ID Tubing OD | AN Dash No. | Torque: Straight or Bulkhead Threads | Torque: Raybould Fitting: Steel Tubing | Torque: Raybould Fitting: Aluminum Tubing |
|---|---|---|---|---|
| 1/4 | 4 | 100 lb in. | 45 lb in. | |
| 3/8 | 6 | 125 lb in. | 125 lb in. | |
| 1/2 | 8 | 200 lb in. | 175 lb in. | 95 lb in. |
| 5/8 | 10 | 275 lb in. | 200 lb in. | |
| 3/4 | 12 | 400 lb in. | 200 lb in. | |
| 1 | 16 | 50 lb ft | | |
| 1-1/4 | 20 | 60 lb ft | | |
| 1-1/2 | 24 | 75 lb ft | | |

**TABLE XXIII**

**TORQUE VALUES FOR JAM NUTS FOR FITTINGS USED WITHOUT GASKETS**

| AN Dash No. | Torque: Aluminum or Alloy | Torque: Steel |
|---|---|---|
| 4 | 100 lb in. | 150 lb in. |
| 6 | 135 lb in. | 275 lb in. |
| 8 | 260 lb in. | 450 lb in. |
| 10 | 350 lb in. | 600 lb in. |
| 12 | 50 lb ft | 90 lb ft |
| 16 | 75 lb ft | 150 lb ft |
| 20 | 90 lb ft | |
| 24 | 110 lb ft | |

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